SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Hydrology Based Ecological Habitat Suitability Indices for Evaluating Alternative Water Management Strategies

Presentation
to
Committee on Restoration of the Greater Everglades Ecosystem

By

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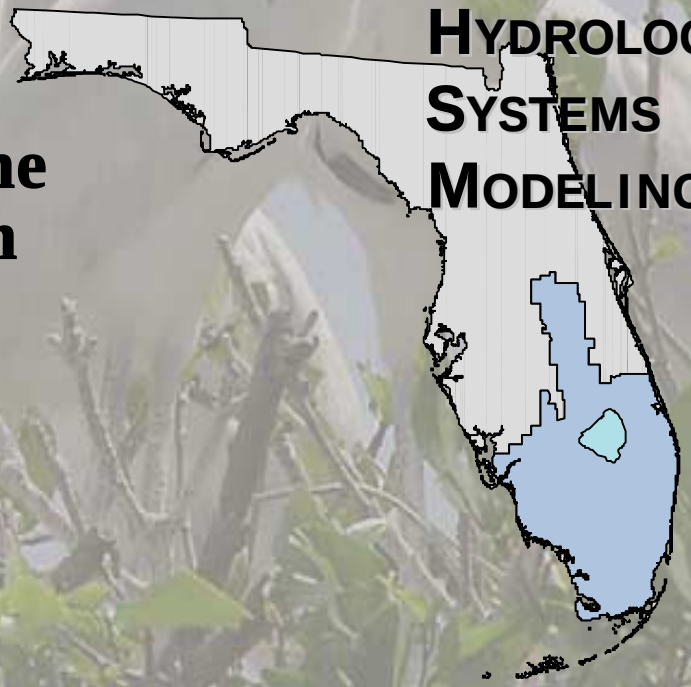
April 27, 2001



HYDROLOGIC SYSTEMS MODELING

Multi-Agency, Interdisciplinary Team

Coordinators
- Ken Tarboton
- Pete Loucks
- Steve Davis
- Jayantha Obeysekera

Hydrology & Modeling
- Raul Novoa
- Sharika Senarath
- Lehar Brion
- Jenifer Barnes
- Danielle Lyons

Ecology

Periphyton
- Evelyn Gaiser
- Dan Childers
- Joan Browder
- Sue Newman
- Linda Blum
- Rebecca Sharitz

Alligators
- Laura Brandt
- Frank Mazzotti
- Ken Rice

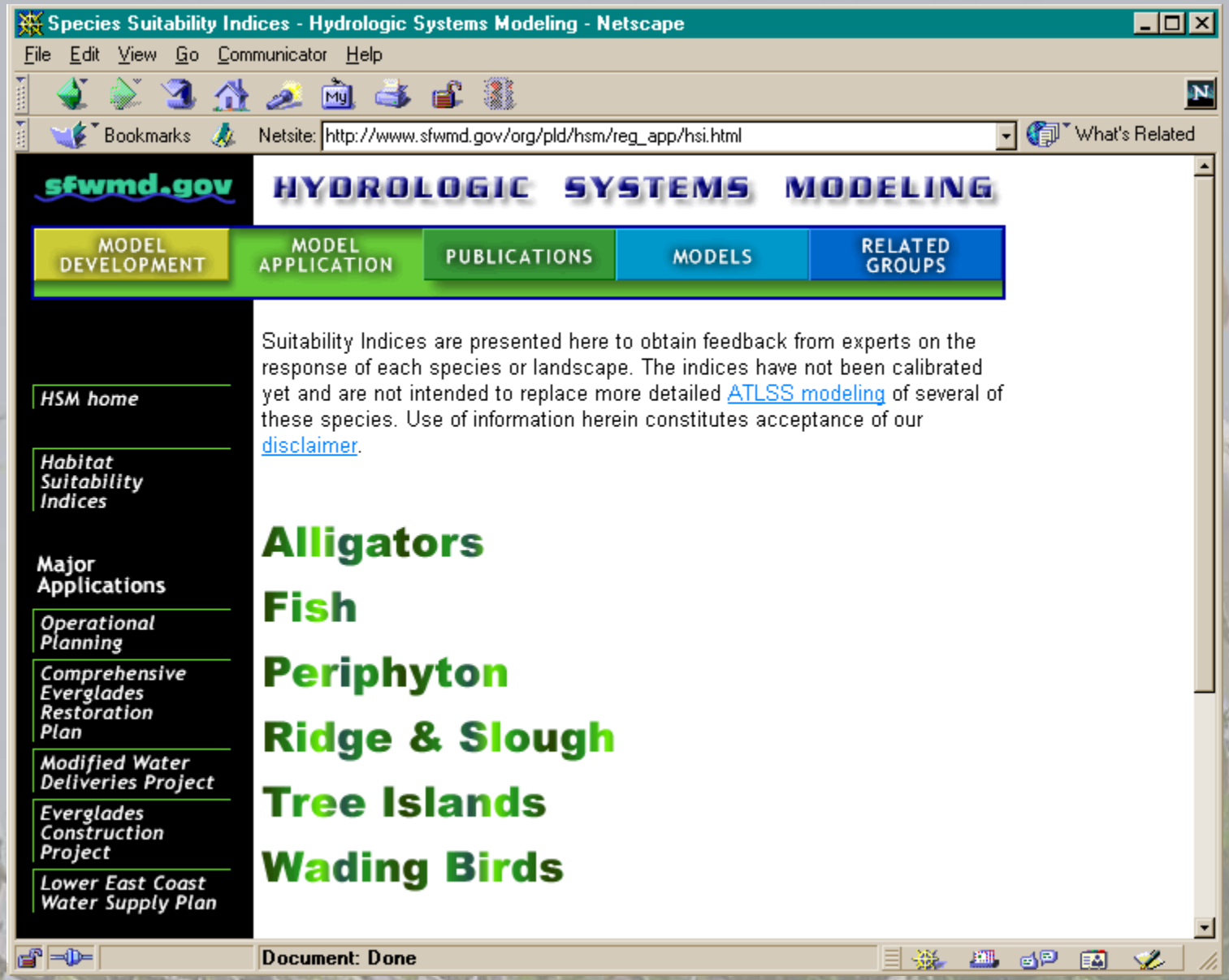
Ridge & Slough
- Chris McVoy

Tree Islands
- Lorraine Heisler
- Yegang Wu
- Carl Fitz
- Fred Sklar
- Chris McVoy

Wading Birds
- Dale Gawlik
- Gaea Crozier

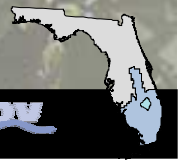
Fish
- Joel Trexler
- Bill Loftus

www.sfwmd.gov/org/pld/hsm/reg_app/hsi.html



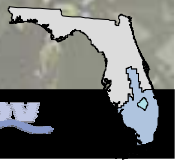
Overview

- **Objectives**
- **Development of Indices**
  - Concepts and examples
  - Periphyton, Fish and Alligators
- **Verification and calibration**
  - Wading Birds
- **Comparison and Combination**
- **Management Scenarios**
- **Sensitivity**
  - Ridge and Slough



Objectives

- Create linkage between hydrologic stressors and ecological response
- Create “broad brush” simple but useful indices to quantify ecological response to different water management alternatives
- Verify, calibrate and refine indices to increase their usefulness



Objectives continued ...

- **Use indices to provide more information on CERP ...**
  - Did we get the water right?
  - A there opportunities for changing hydrology to improve ecology? Where?
  - Evaluate “what if” scenarios and their effect on habitat.
- **Potential tool for use by RECOVER in regional evaluations during detailed design and implementation**

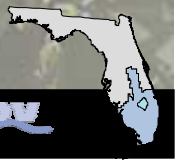
Development of Indices

1. Identify appropriate habitat indicators.
2. Define habitat suitability indices in terms of hydrologic stressors.
3. Use hydrologic model output (stressor) to obtain suitability index or time series of suitability values.
4. Combine sub-indices (if any) to get habitat suitability index or time series of SI's for each habitat.
5. Compute summary statistics for habitat suitability indices.

Development of Indices

1. Identify appropriate habitat indicators.

   - Periphyton
   - Fish
   - Wading Birds
   - Alligators
   - Tree Islands
   - Ridge and Slough landscape



Development of Indices

2. Define habitat suitability indices in terms of hydrologic stressors.

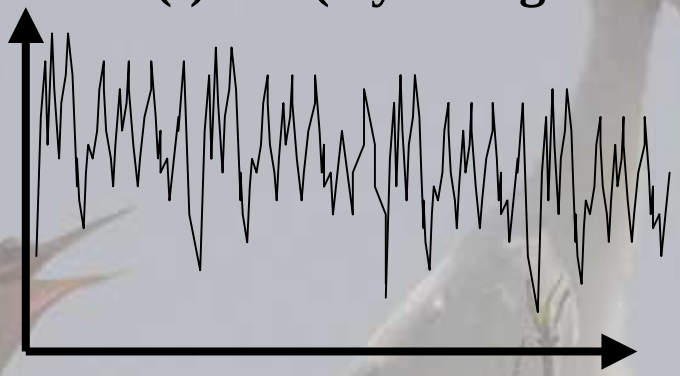
Sample Hydrologic Stressors

- Water Depth
  - average (weekly, monthly, annual, between specified dates)
  - min, max, above/below thresholds
- Flow Direction
- Flow Velocity
- Time related
  - hydroperiods - discontinuous/continuous
  - time since last drydown
  - period below/above thresholds
  - rates of recession

Development of Indices

3. Use hydrologic model output (stressor) to obtain suitability index or time series of suitability values.

Stressor(t) = fn(Hydrologic Variables(t))



Time

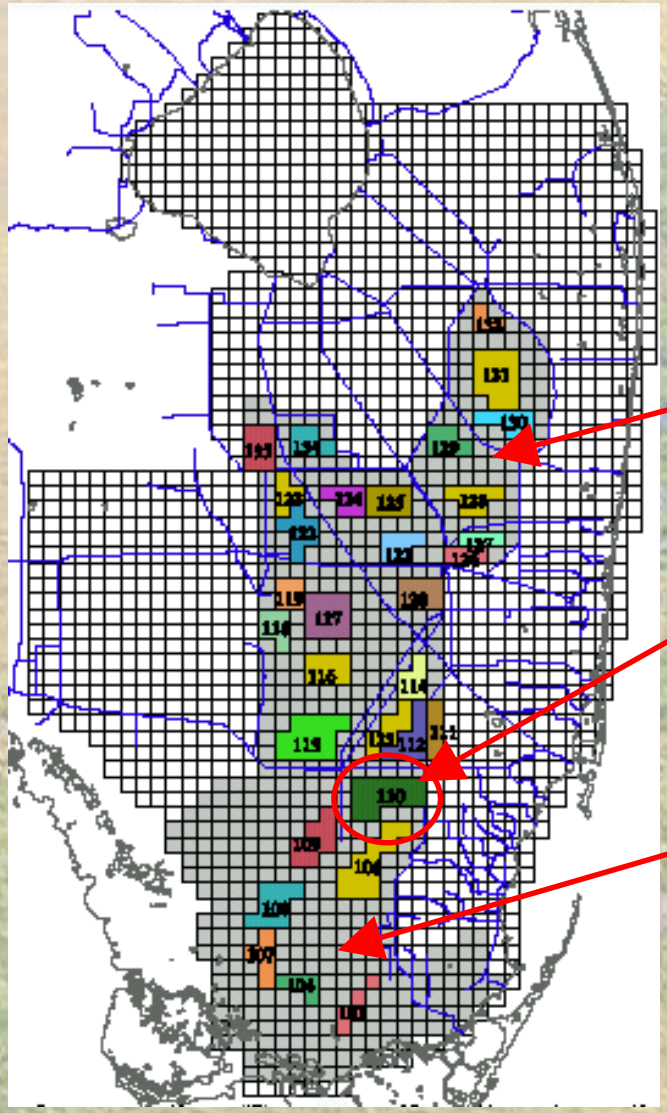
Suitability = fn(Stressor)

Suitability Index

Suitability(t) = fn(Stressor(t))

Habitat Suitability Indices

South Florida Water Management Model



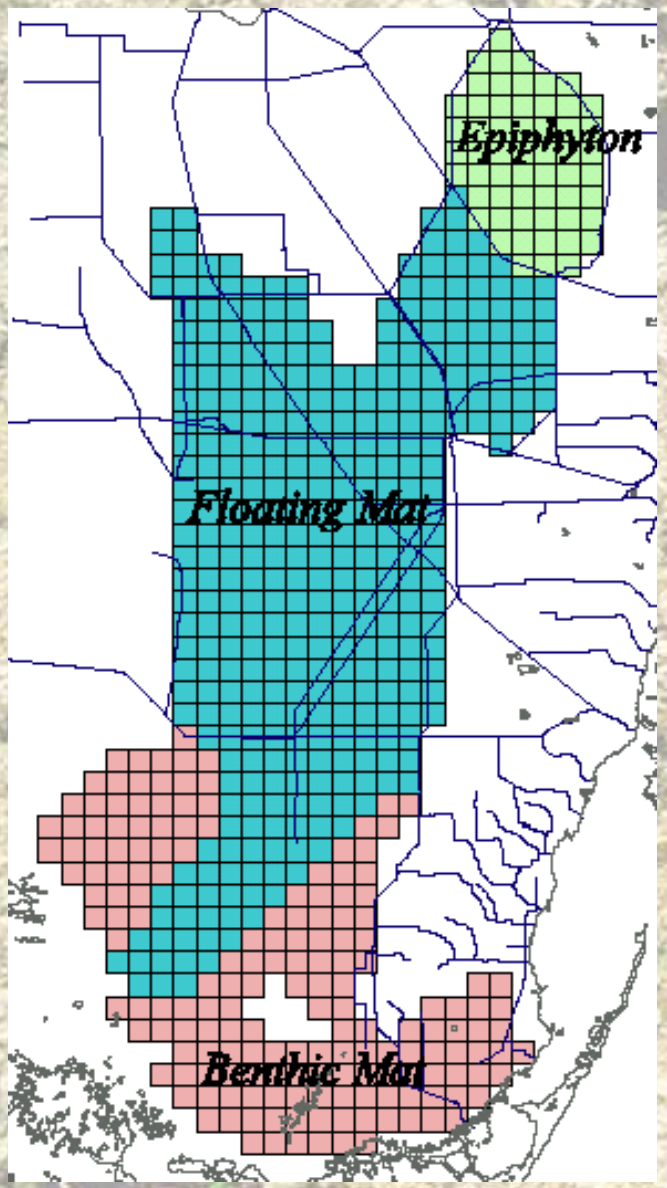
Obtained For

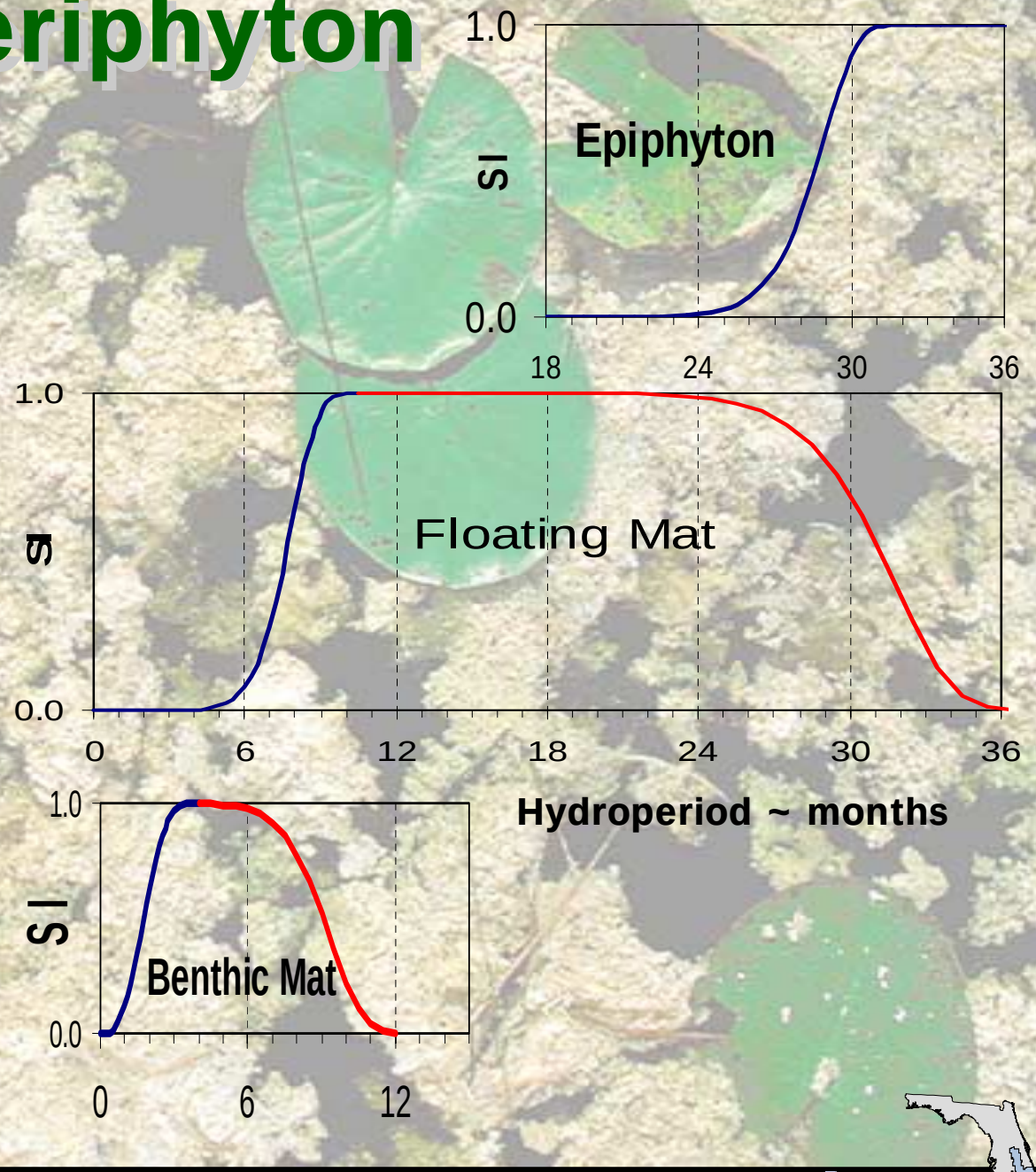
Individual cells

Indicator Regions

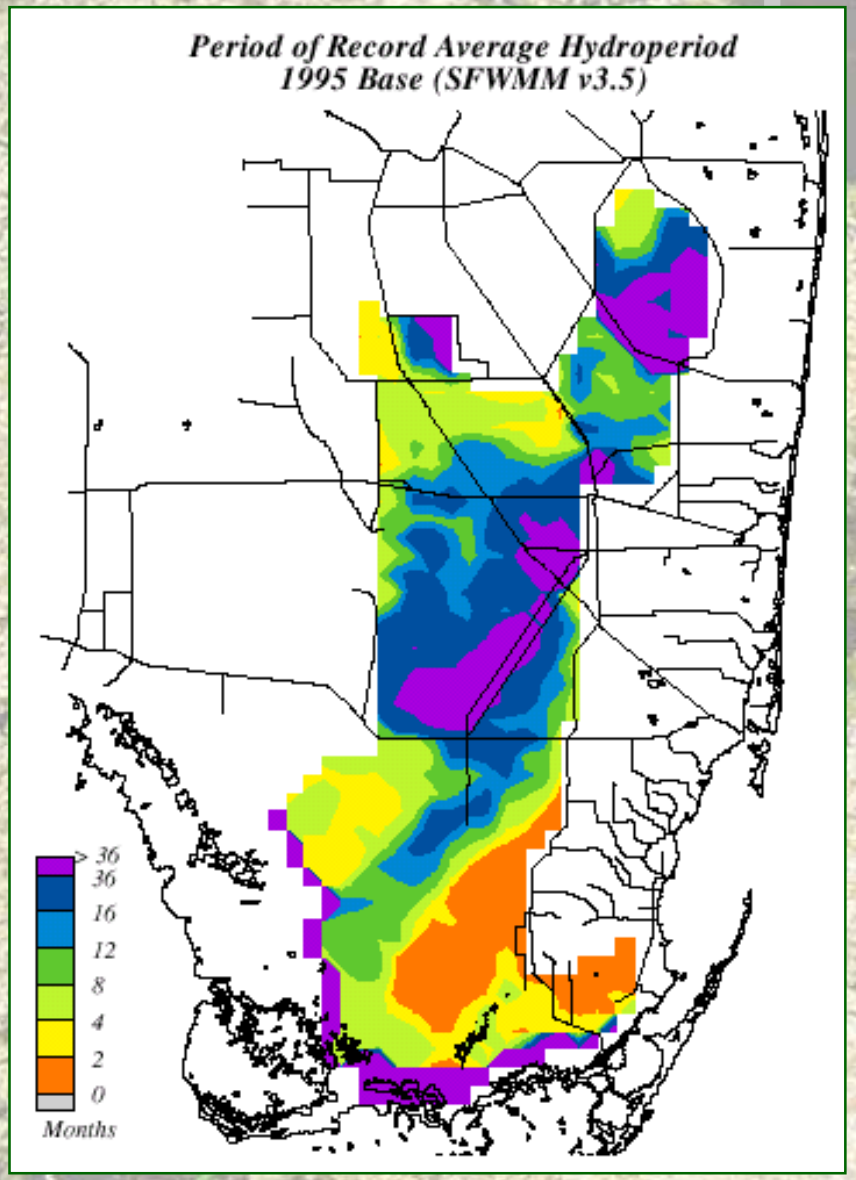
Landscapes

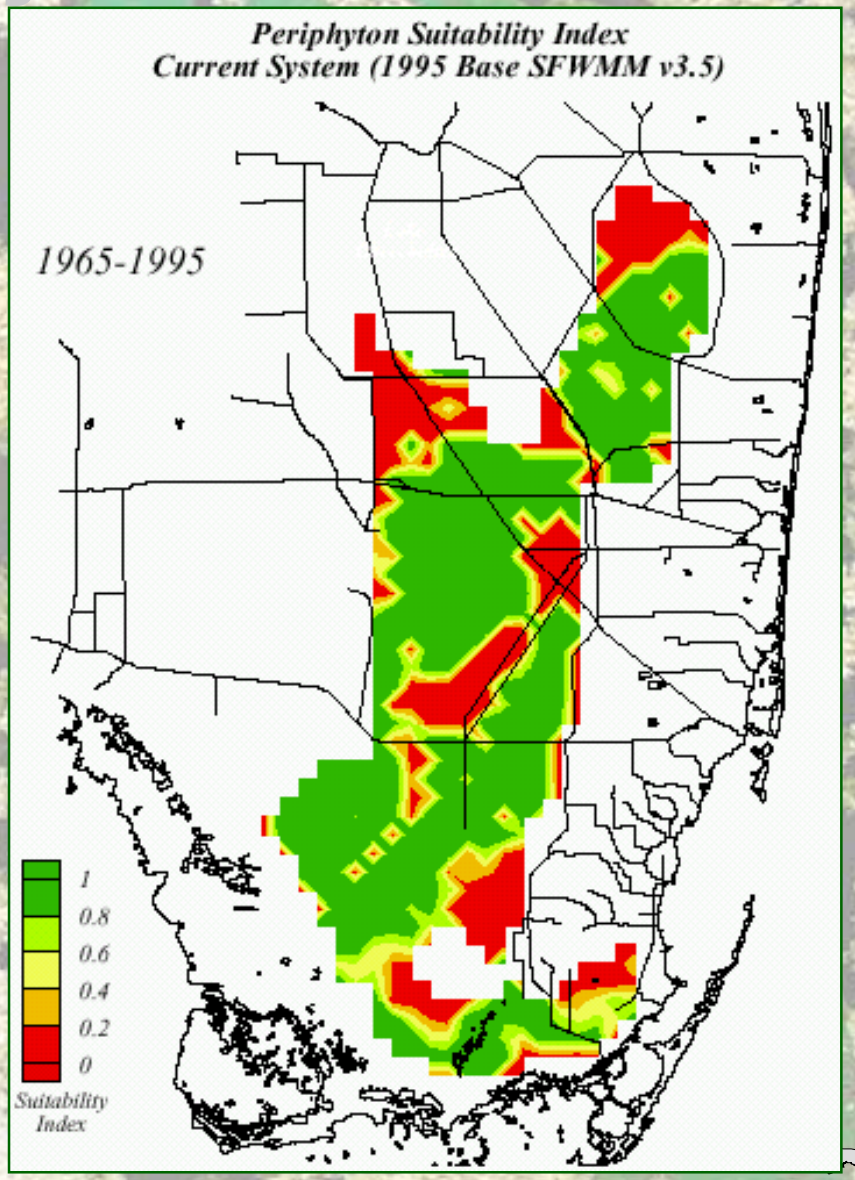
Periphyton


Epiphyton
Floating Mat
Benthic Mat


1.0
SI
0.0
Epiphyton
18
24
30
36
1.0
SI
0.0
Floating Mat
0
6
12
18
24
30
36
Hydroperiod ~ months
1.0
SI
0.0
Benthic Mat
0
6
12

Periphyton

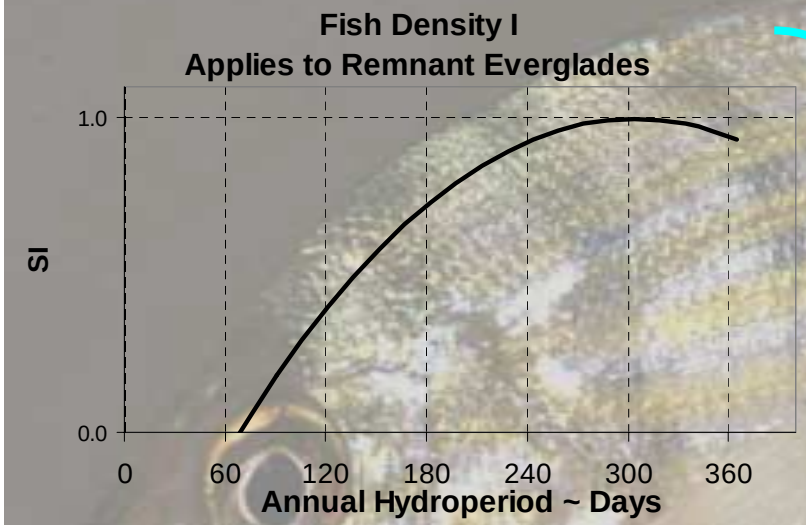

Period of Record Average Hydroperiod
1995 Base (SFWMM v3.5)
> 36
36
16
12
8
4
2
0
Months

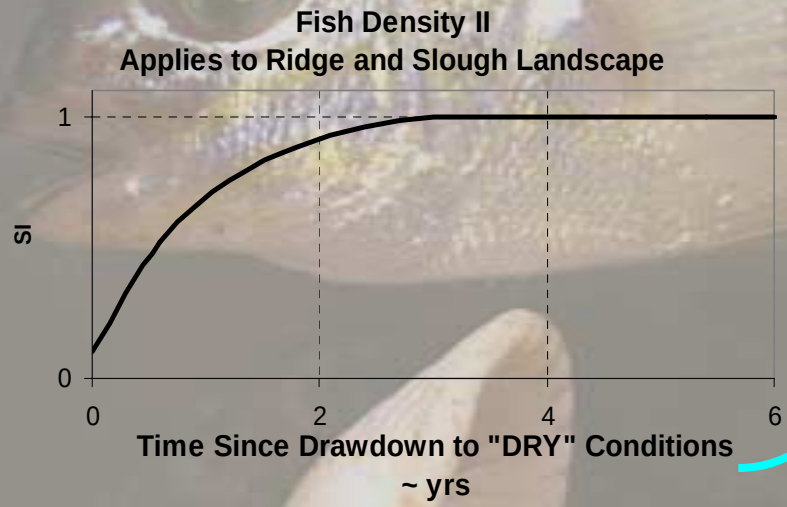

Periphyton Suitability Index
Current System (1995 Base SFWMM v3.5)
1965-1995
1
0.8
0.6
0.4
0.2
0
Suitability Index

Development of Indices

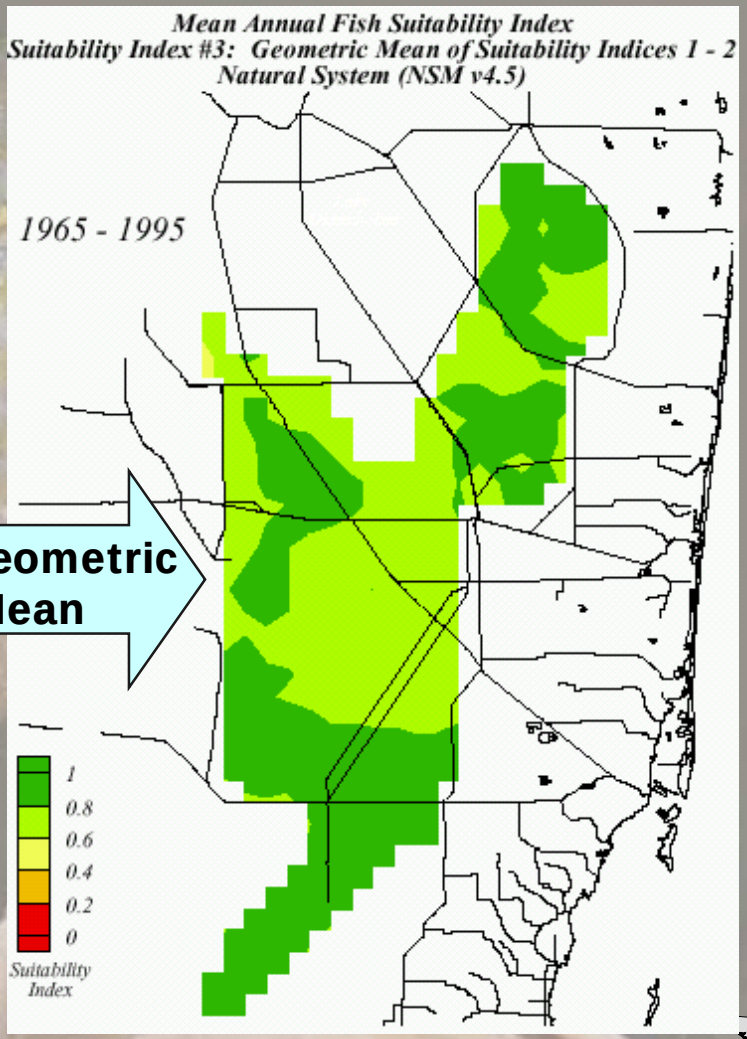
4. Combine sub-indices to get habitat suitability index or time series of SI's for each habitat.

Fish



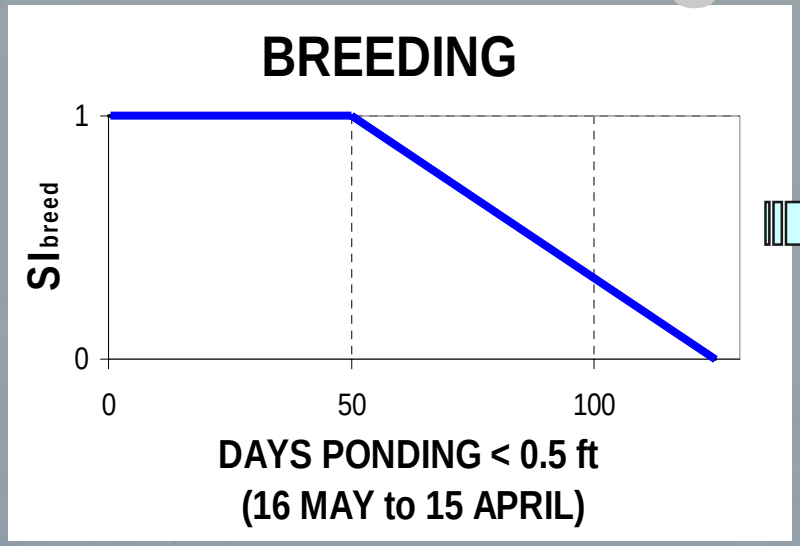


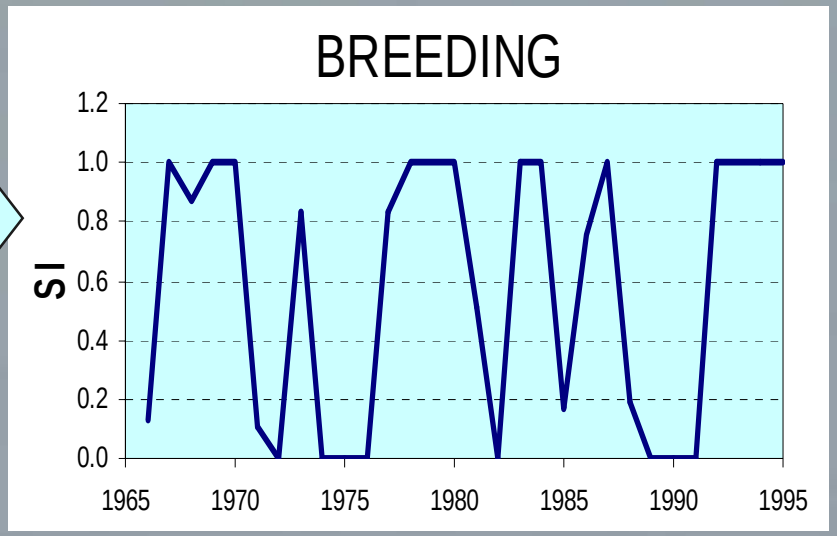
Geometric Mean

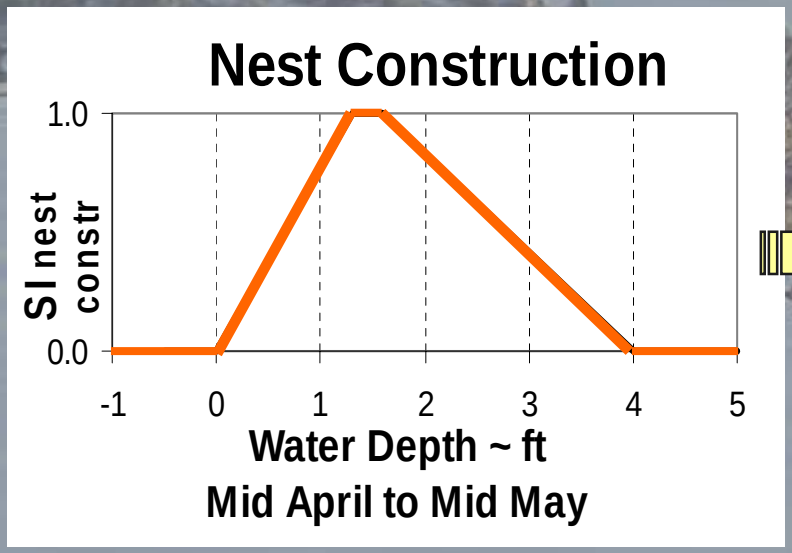


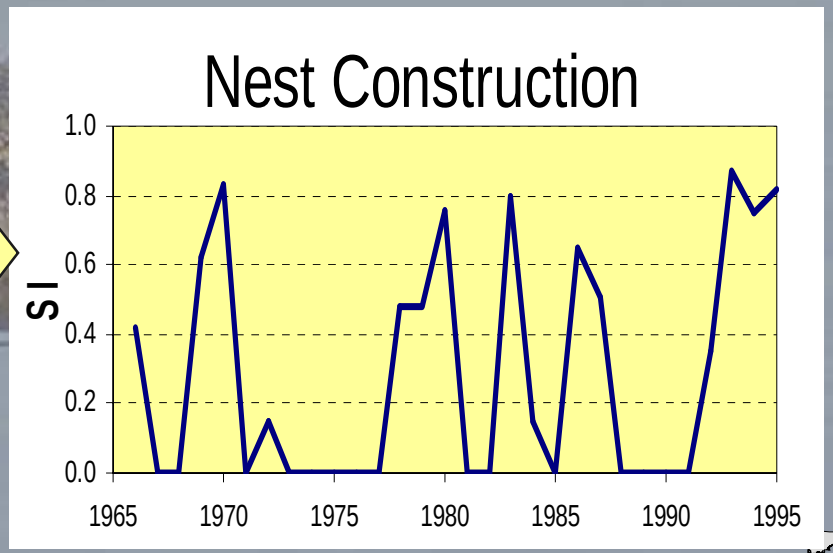
Alligators

Shark River Slough
Current Conditions



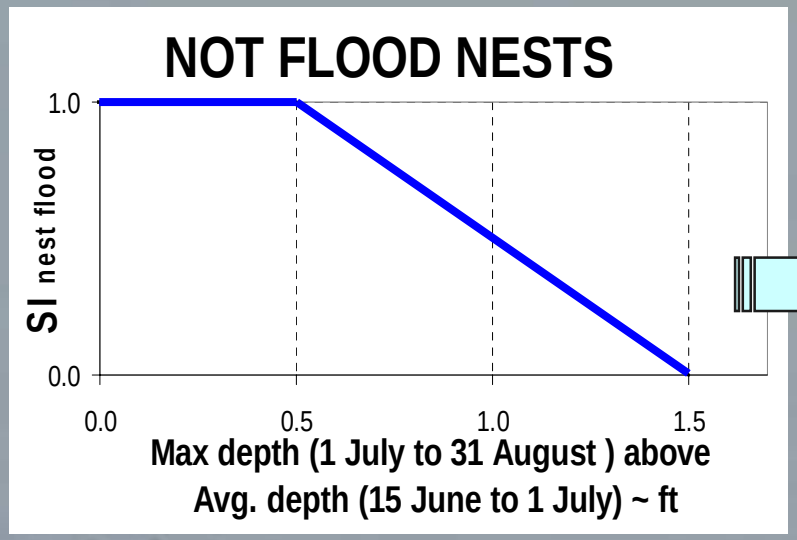


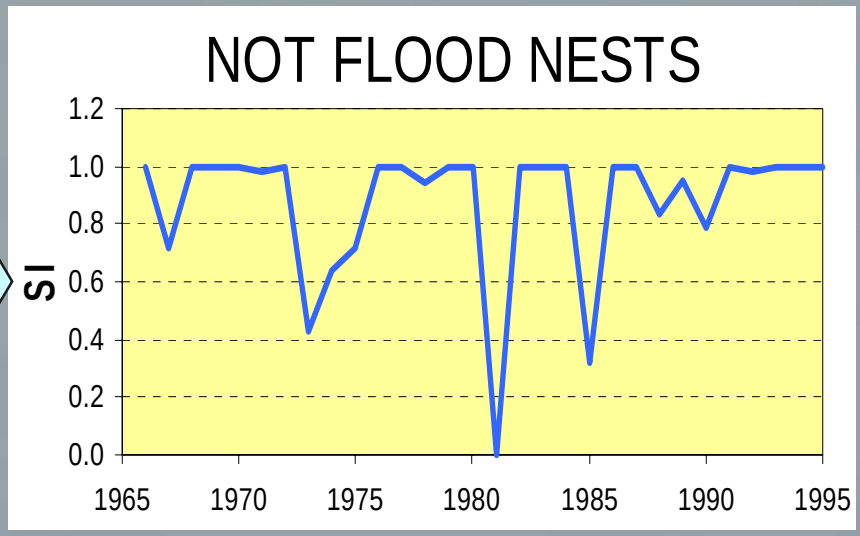


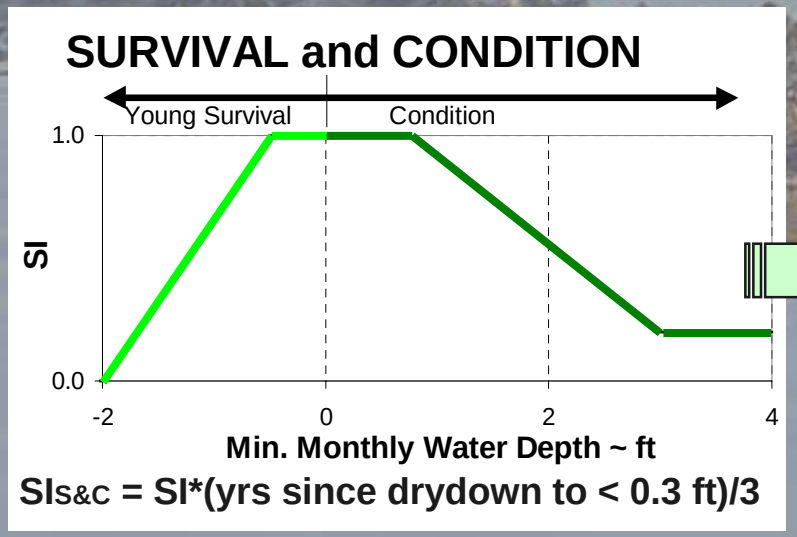


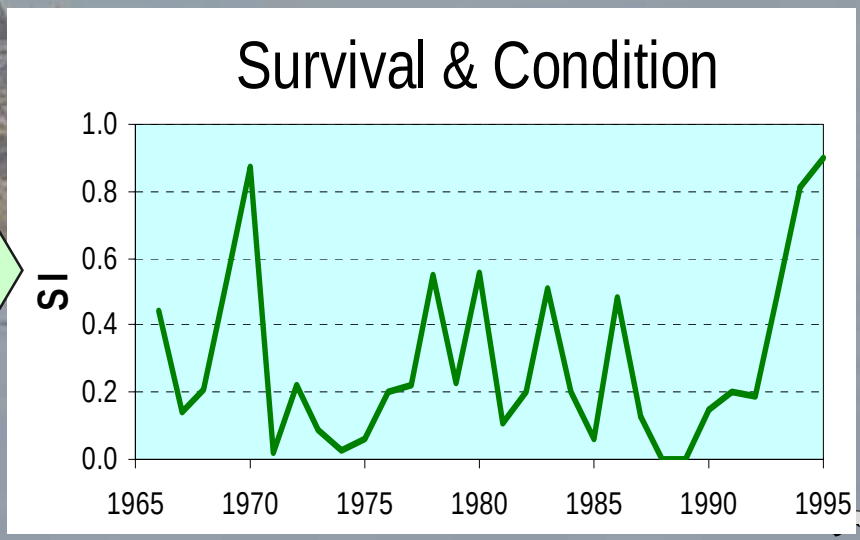
Alligators

Shark River Slough Current Conditions

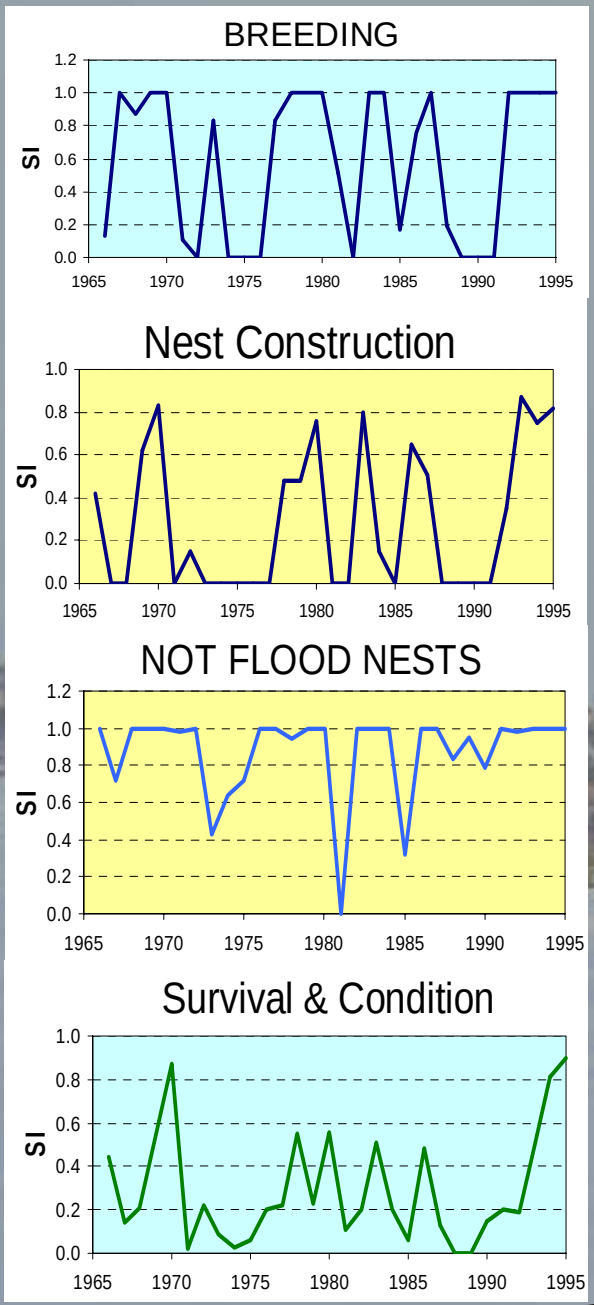


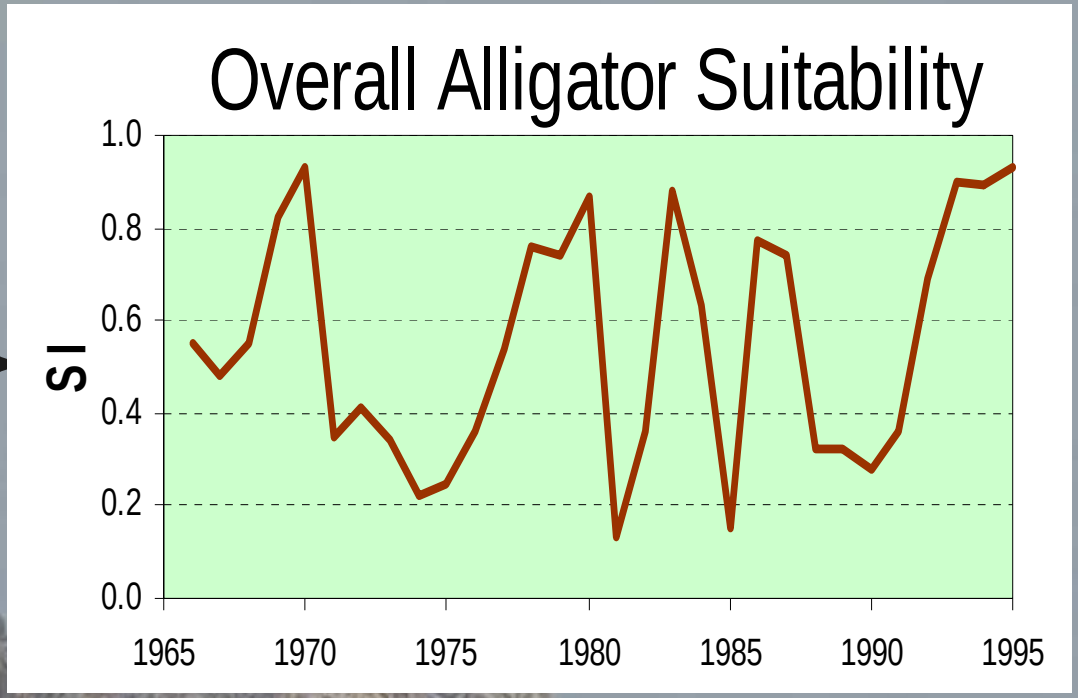






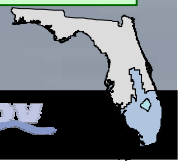
Shark River Slough
Current System





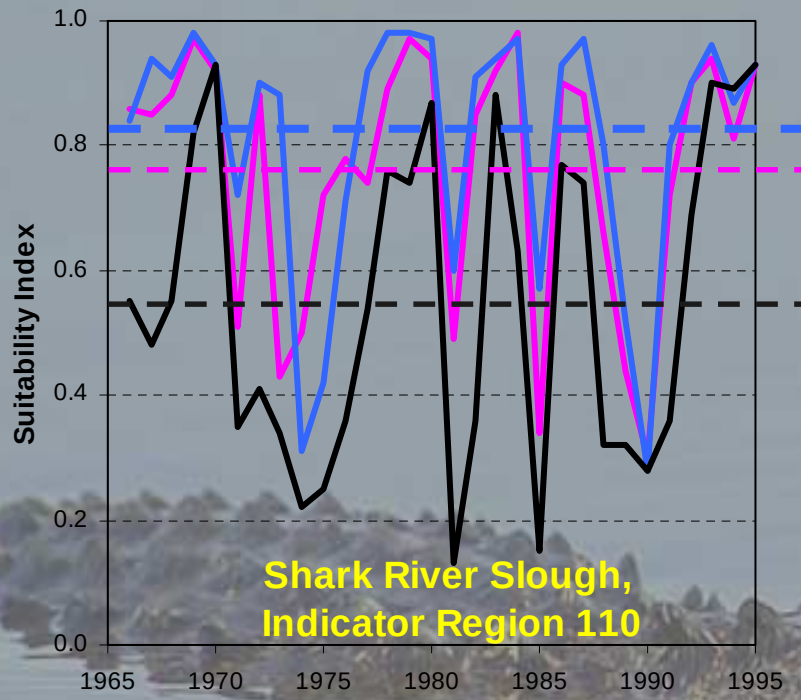
Weighted Mean

$$SI_{Alligator} = [3(SI_{breed}) + 3(SI_{nest\ constr}) + 2(SI_{nest\ flood}) + (SI_{surv+cond})]/9$$



Development of Indices

5. Compute summary statistics for habitat suitability indices.

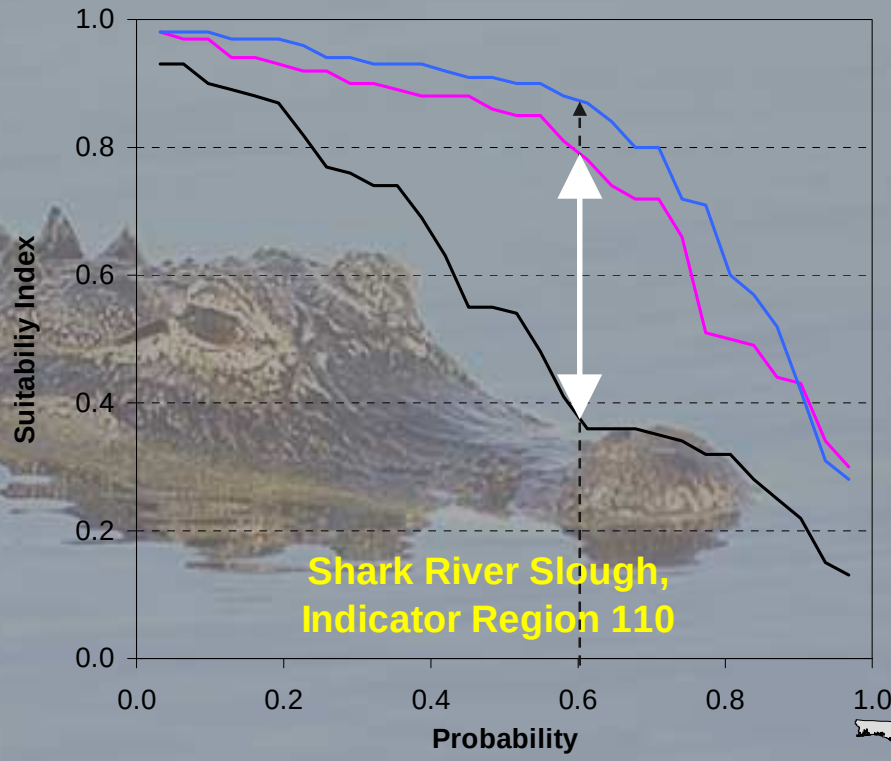


CERP Mean = 0.81

NSM Mean = 0.76

Current Mean = 0.55

Alligators

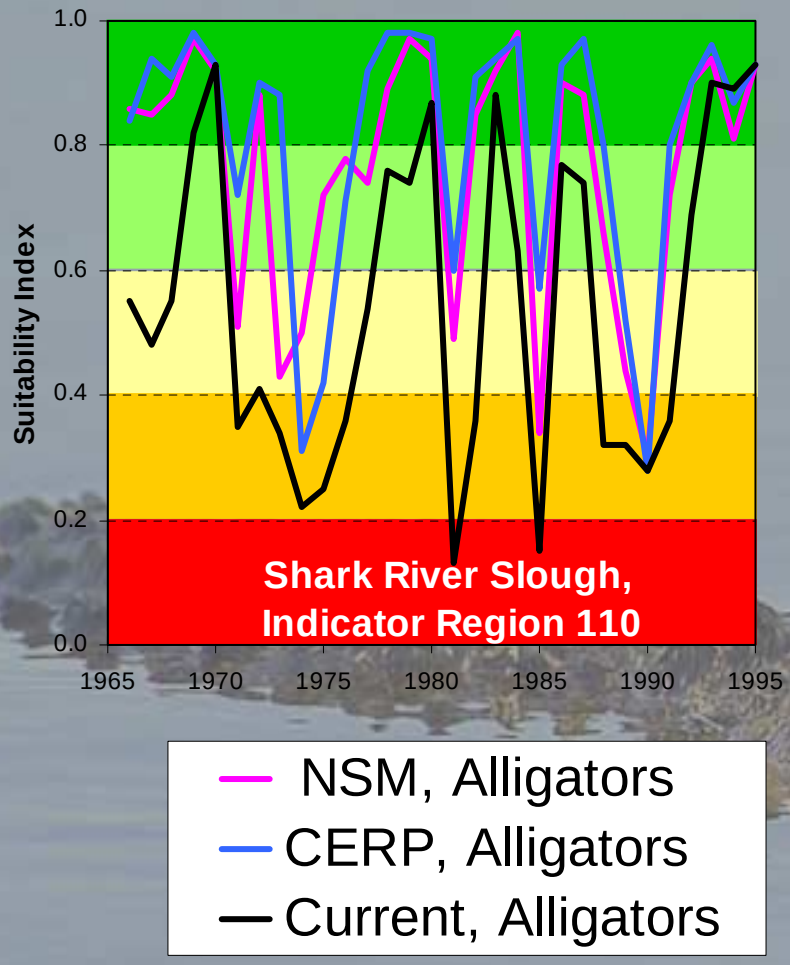


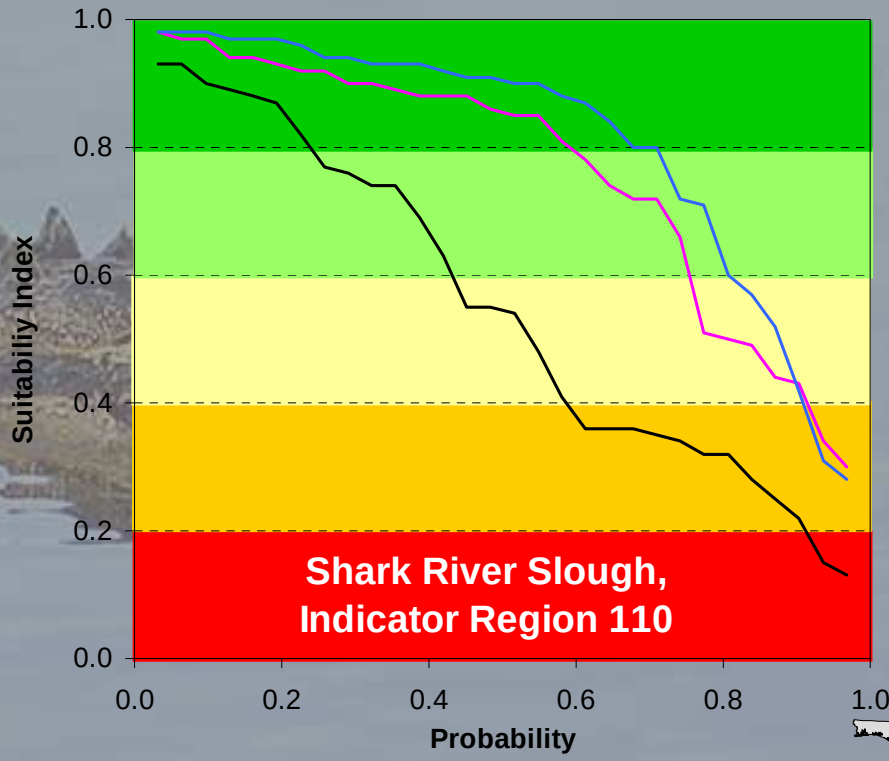
NSM, Alligators

CERP, Alligators

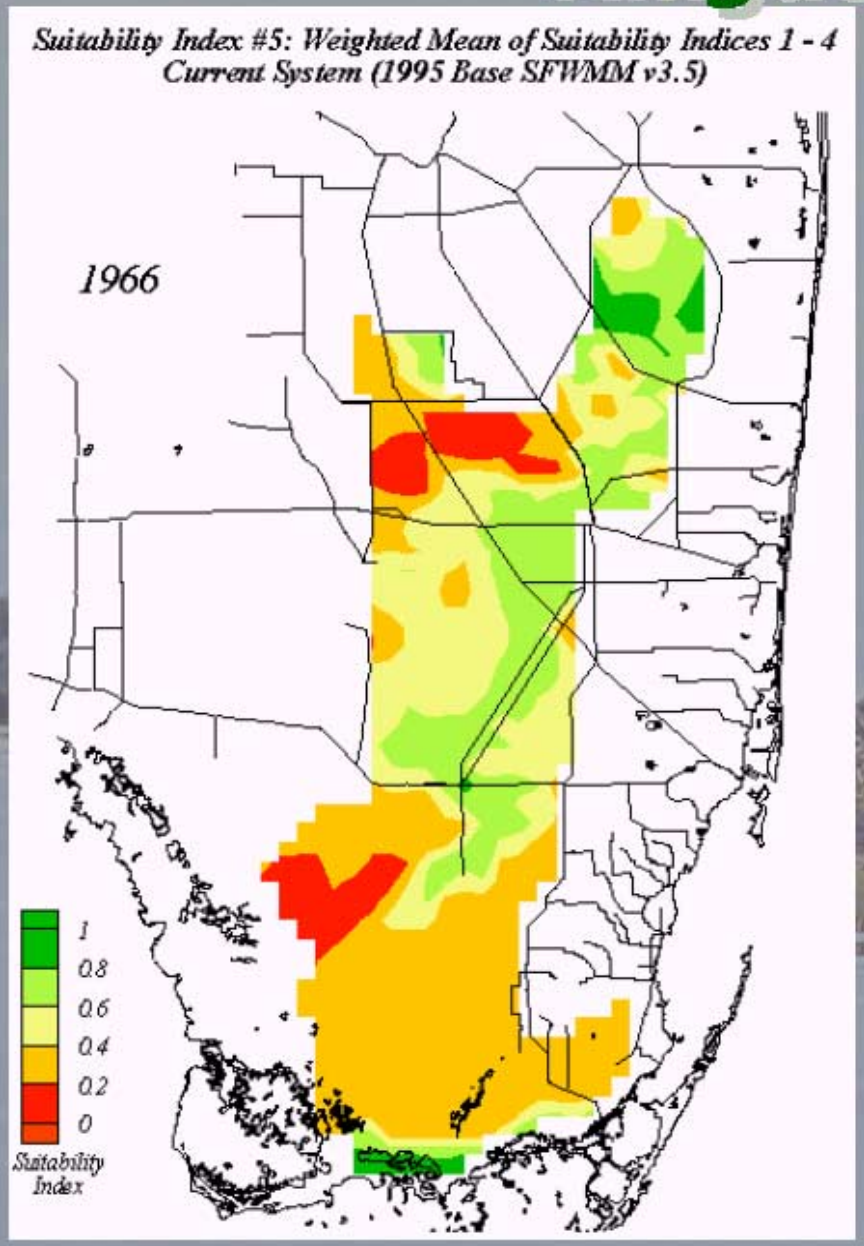
Current, Alligators

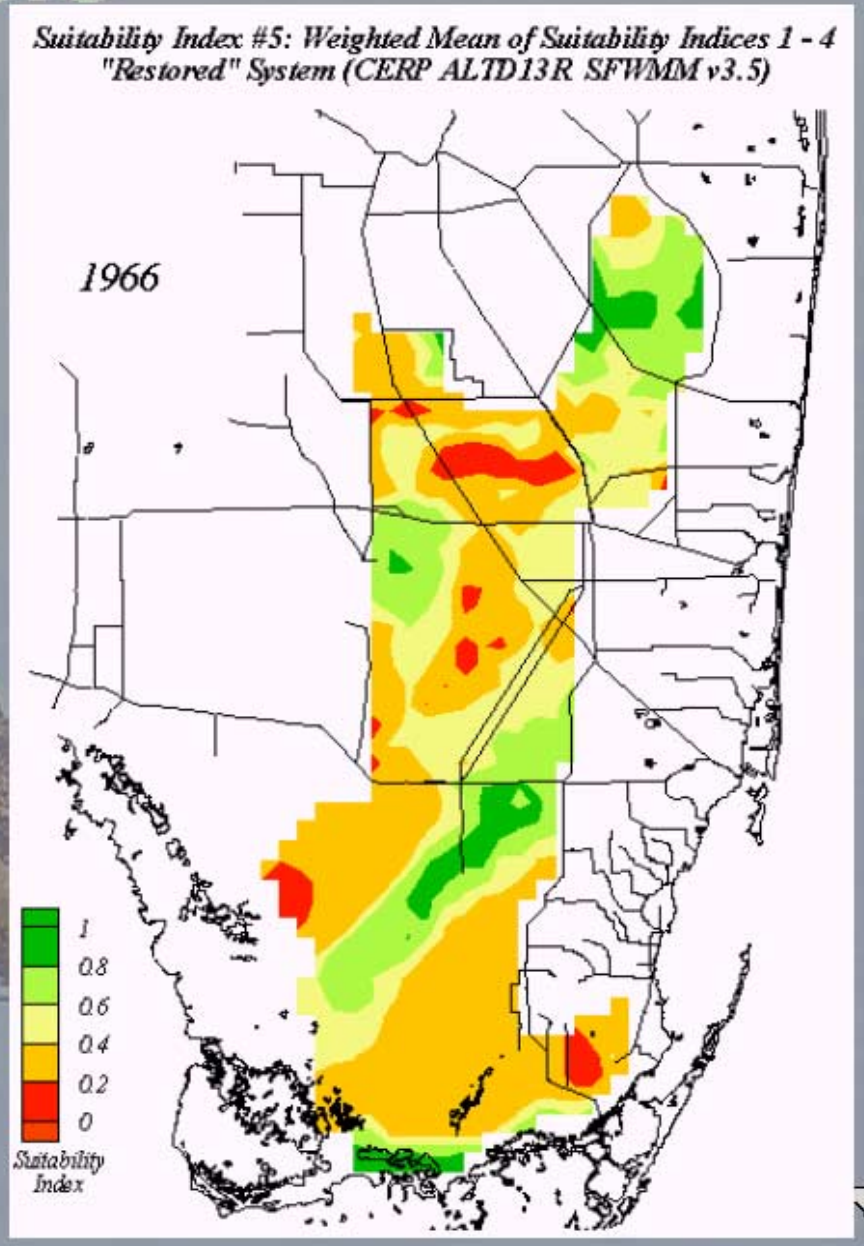
Alligators


1.0
0.8
0.6
0.4
0.2
0.0
Suitability Index
1965
1970
1975
1980
1985
1990
1995
Shark River Slough,
Indicator Region 110
NSM, Alligators
CERP, Alligators
Current, Alligators


1.0
0.8
0.6
0.4
0.2
0.0
Suitabiliy Index
0.0
0.2
0.4
0.6
0.8
1.0
Probability
Shark River Slough,
Indicator Region 110

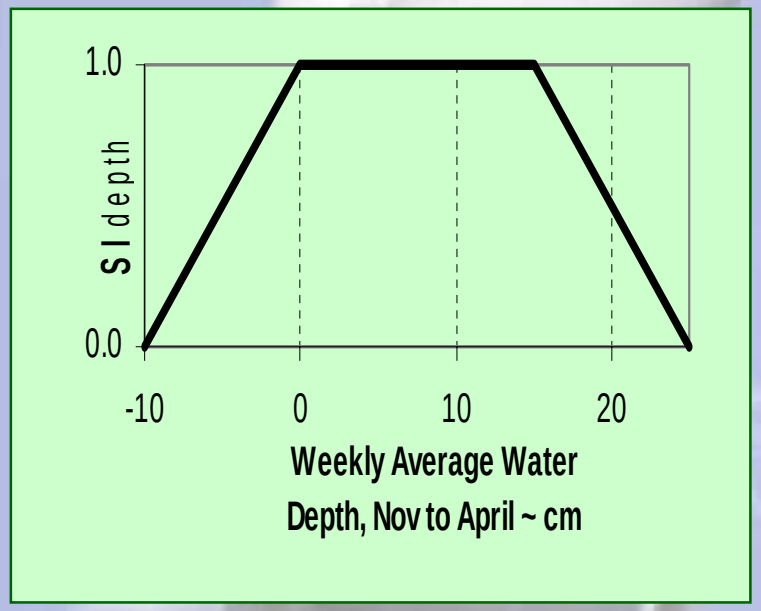
Alligators

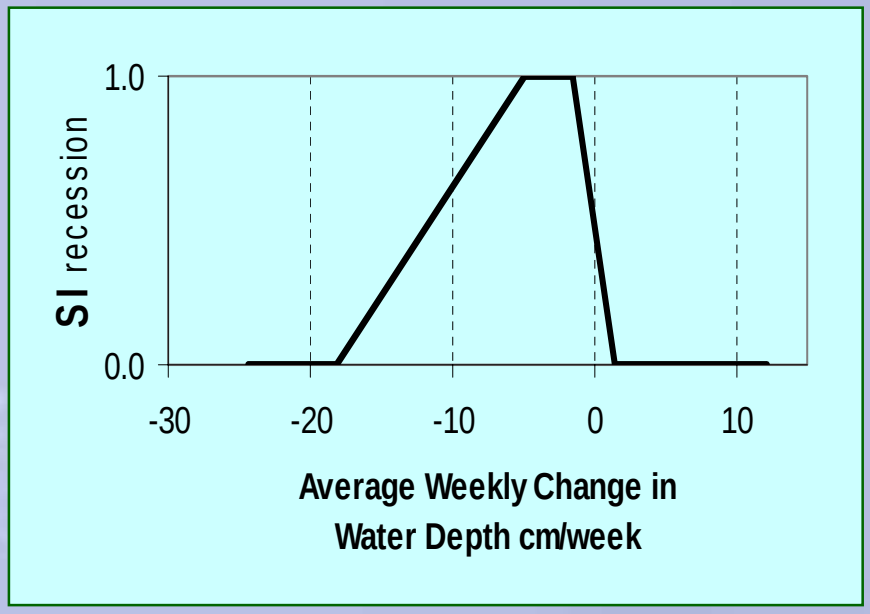

Suitability Index #5: Weighted Mean of Suitability Indices 1 - 4
Current System (1995 Base SFWMM v3.5)
1966
1
0.8
0.6
0.4
0.2
0
Suitability Index

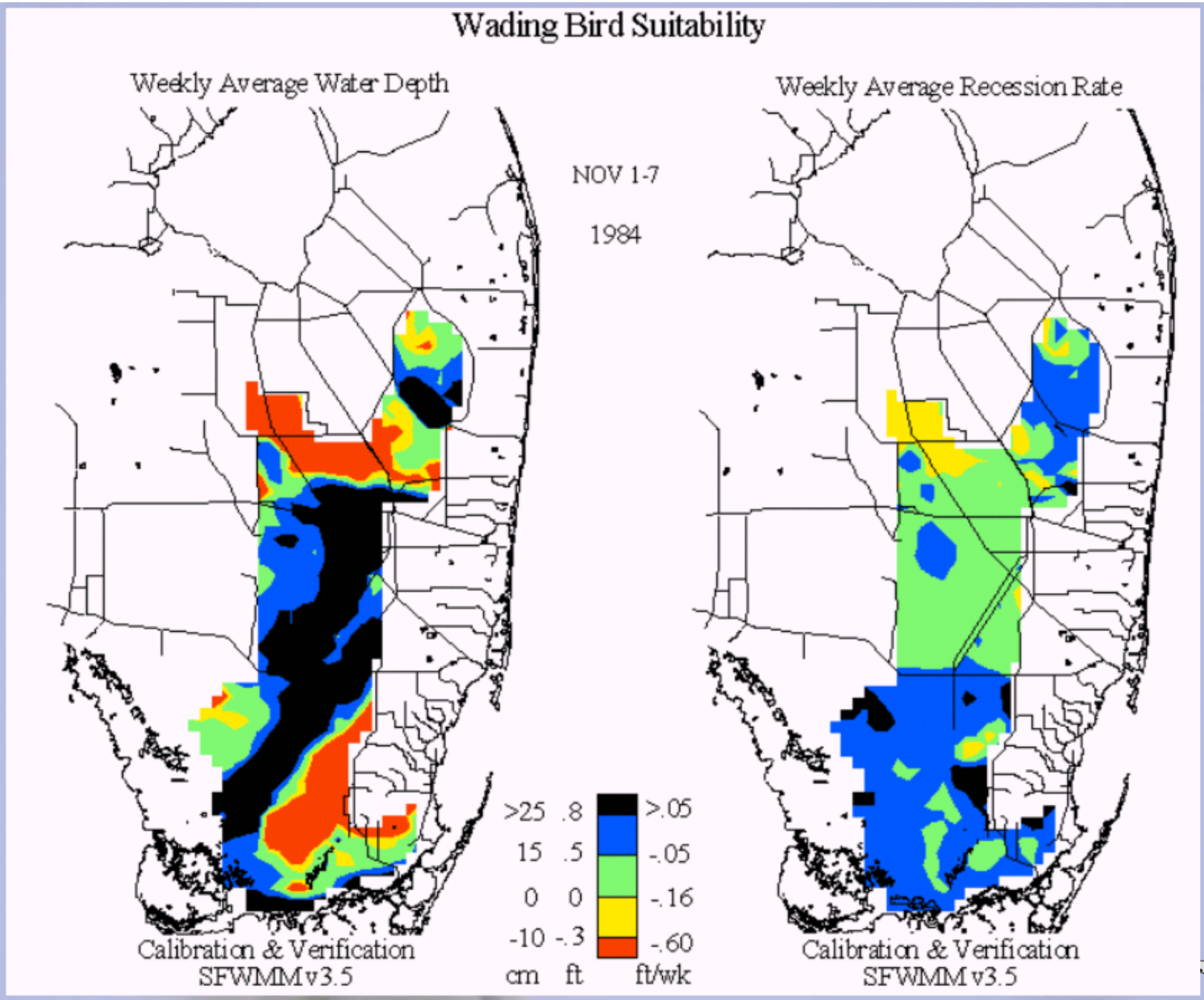

Suitability Index #5: Weighted Mean of Suitability Indices 1 - 4
"Restored" System (CERP ALTD13R SFWMM v3.5)
1966
1
0.8
0.6
0.4
0.2
0
Suitability Index

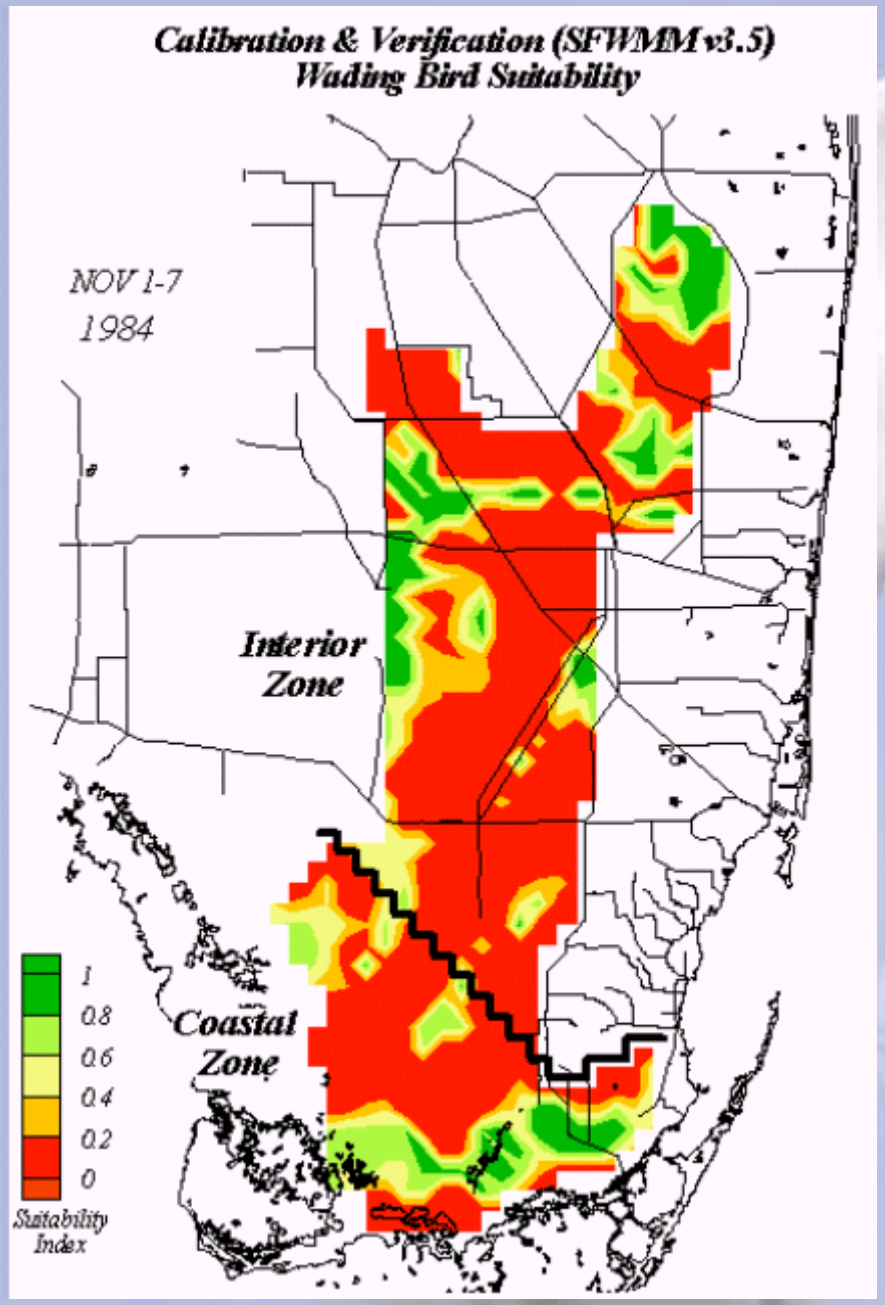
Verification and Calibration

Wading Bird Suitability Sub-Indices






Wading Bird Suitability
Weekly Average Water Depth
NOV 1-7
1984
Weekly Average Recession Rate
>25 .8
15 .5
0 0
-10 -.3
cm ft
>.05
-.05
-.16
-.60
ft/wk
Calibration & Verification
SFWMM v3.5
Calibration & Verification
SFWMM v3.5



Wading Birds

Grid Cell Suitability

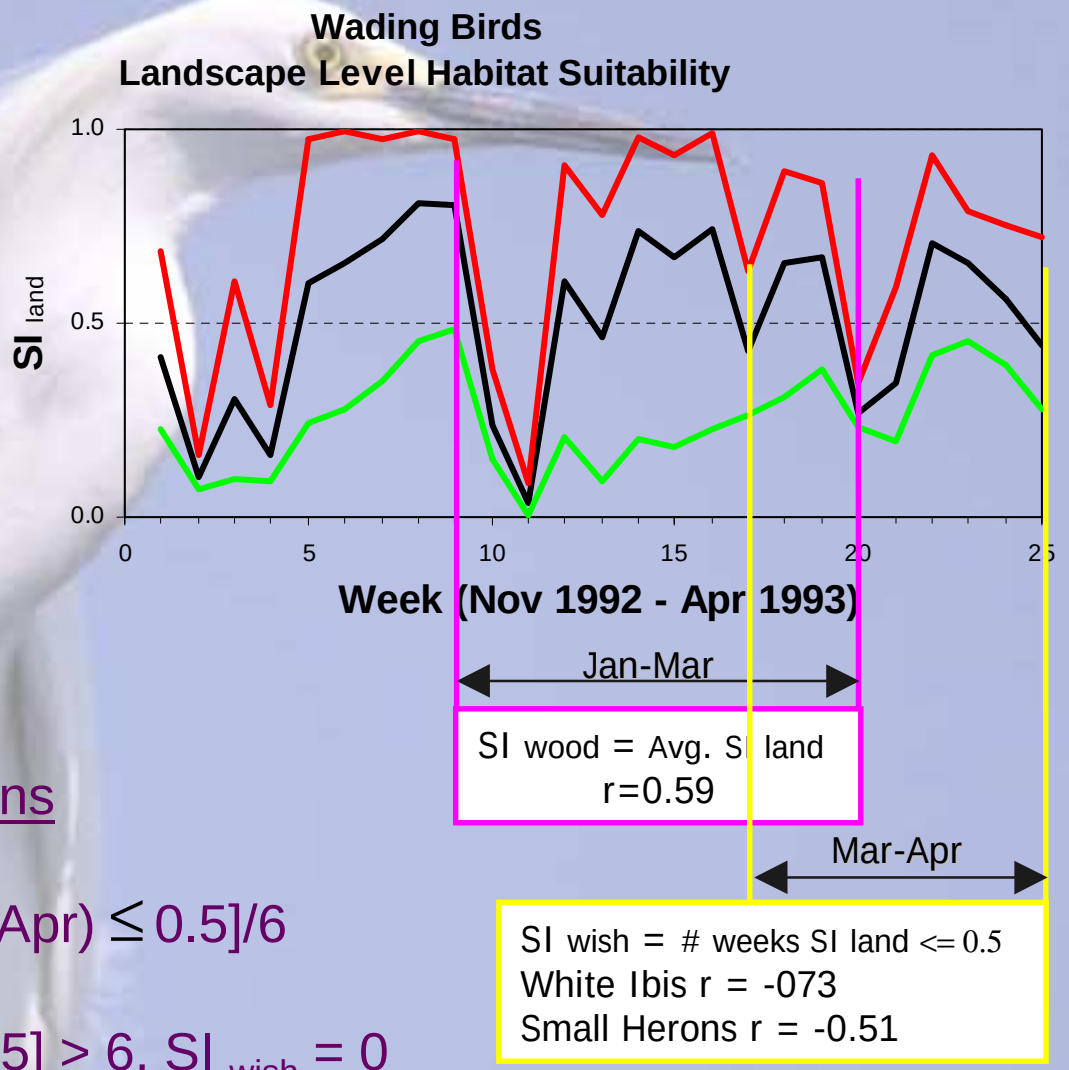
$SI_{WB} = \min(SI_{depth}, SI_{recession})$

Landscape Level Suitability

SI_{land} = avg. SI_{WB} of highest 23 percent of cells for each of

- Remnant Everglades
- Coastal Zone
- Interior Zone

Wading Birds



Wood Storks

$SI_{wost} = \text{mean } SI_{land} \text{ (Jan- Mar)}$

White Ibis and other Small Herons

$SI_{wish} = 1 - [\#\text{ weeks } SI_{land} \text{ (Mar-Apr)} \leq 0.5]/6$

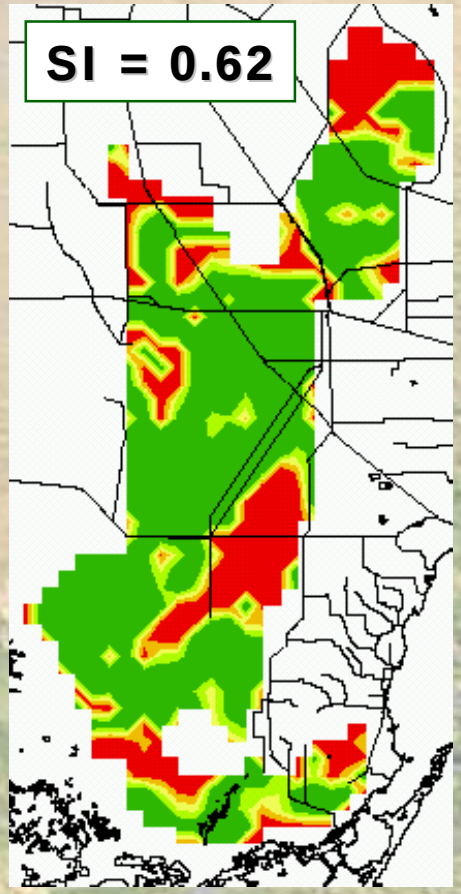
If $[\#\text{ weeks } SI_{land} \text{ (Mar-Apr)} \leq 0.5] > 6$, $SI_{wish} = 0$

Note:
Correlation for SI land for 11 year period 1985-1995. Figure only shows SI land for 1992-1993

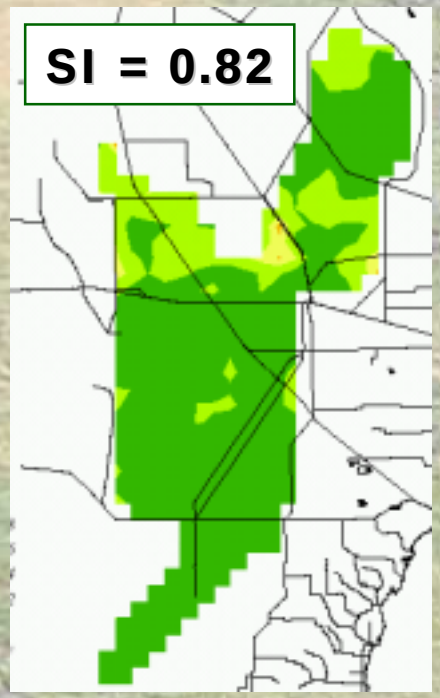
Habitat Suitability Comparisons

Restoration Plan

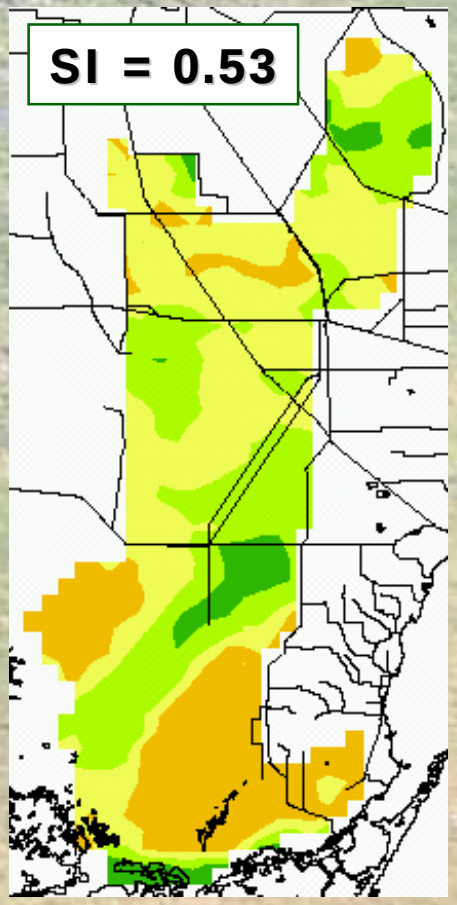
Periphyton



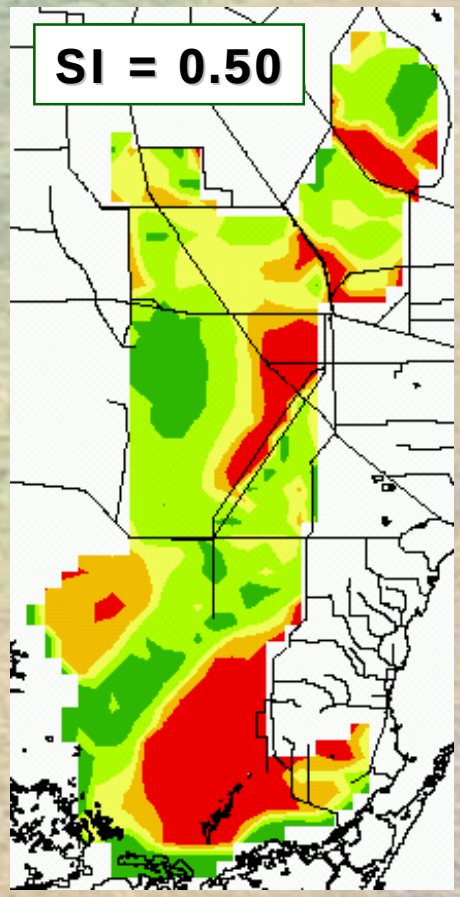
Fish



Alligator

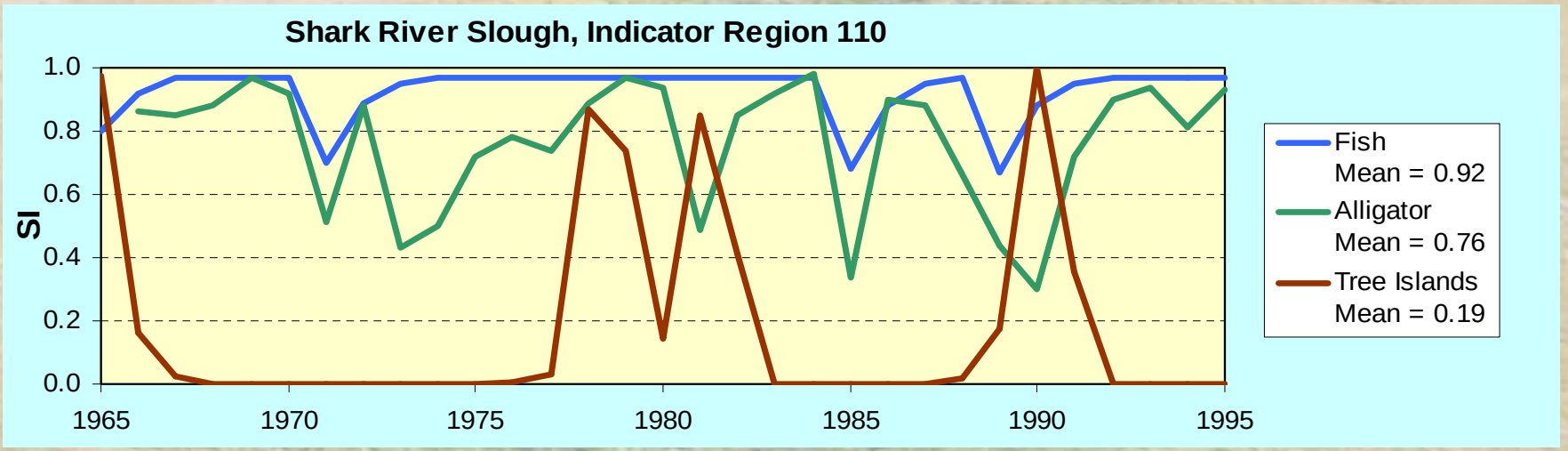


Tree Islands

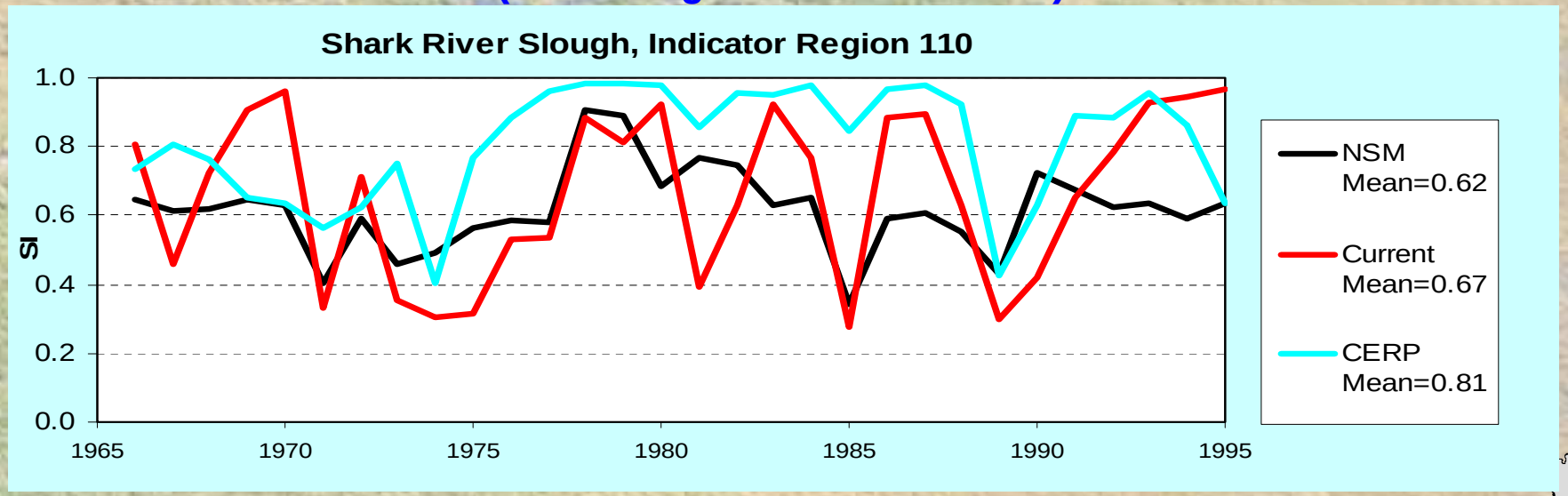


Habitat Suitability Comparisons

Natural System

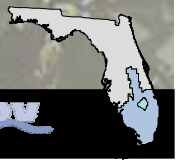


Combined Habitat Index (Fish+Alligator+Tree Islands)

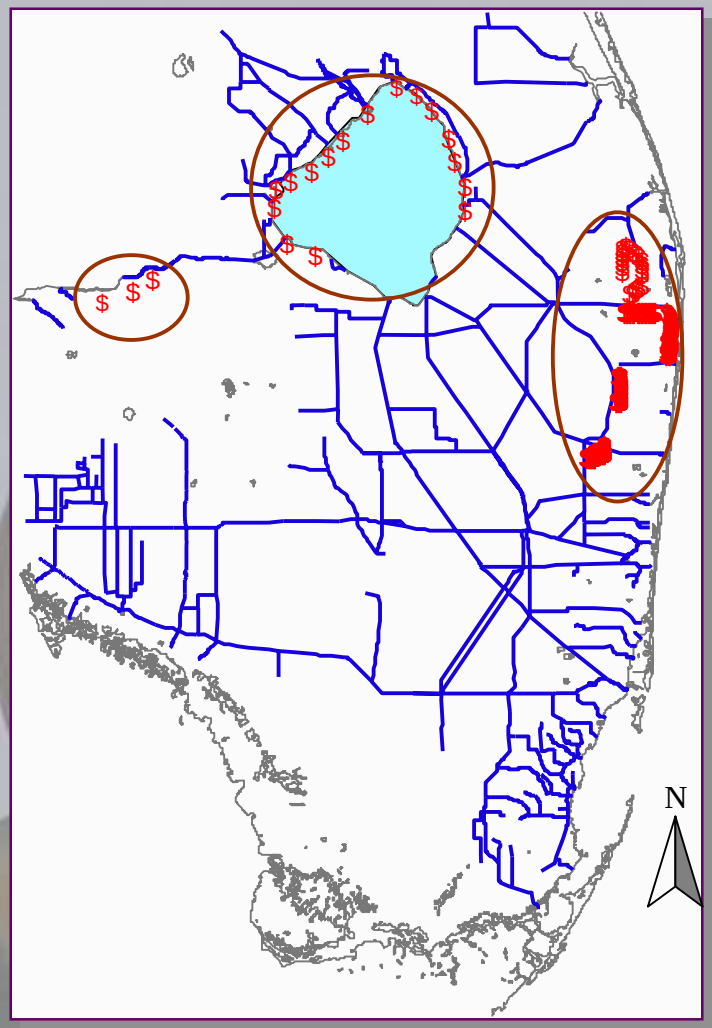


Management Scenarios

- Getting the “Water Right” is a surrogate for getting the “Ecology Right”.
- How do different water management strategies effect ecology?
- Scenarios
  - CERP without any ASR’s
  - CERP without and Lakebelt Storage



Scenario 1: CERP without ASR



Aquifer Storage and Recovery (1665 MGD)

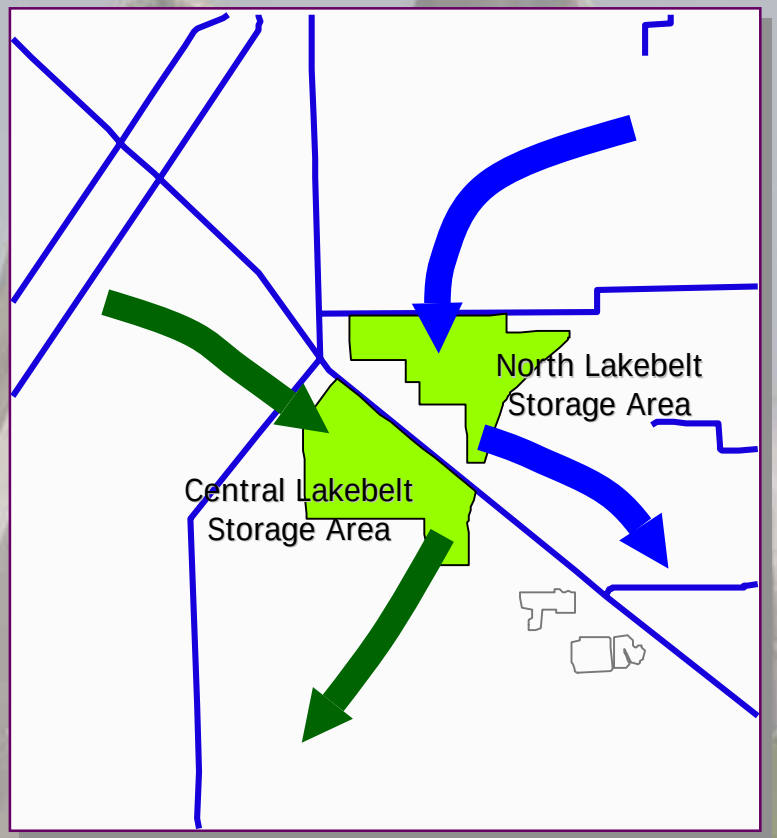
- **Caloosahatchee River Basin ASR (220 MGD)**
- **Lake Okeechobee ASR (1000 MGD)**
- **Lower East Coast Region ASR (445 MGD)**
  - C-51 Regional Groundwater ASR (170 MGD)
  - West Palm Beach Water Catchment Area ASR (50 MGD)
  - Palm Beach County Agricultural Reserve ASR (75 MGD)
  - Hillsboro Site 1 ASR (150 MGD)

Scenario 2: CERP without Lakebelt Storage

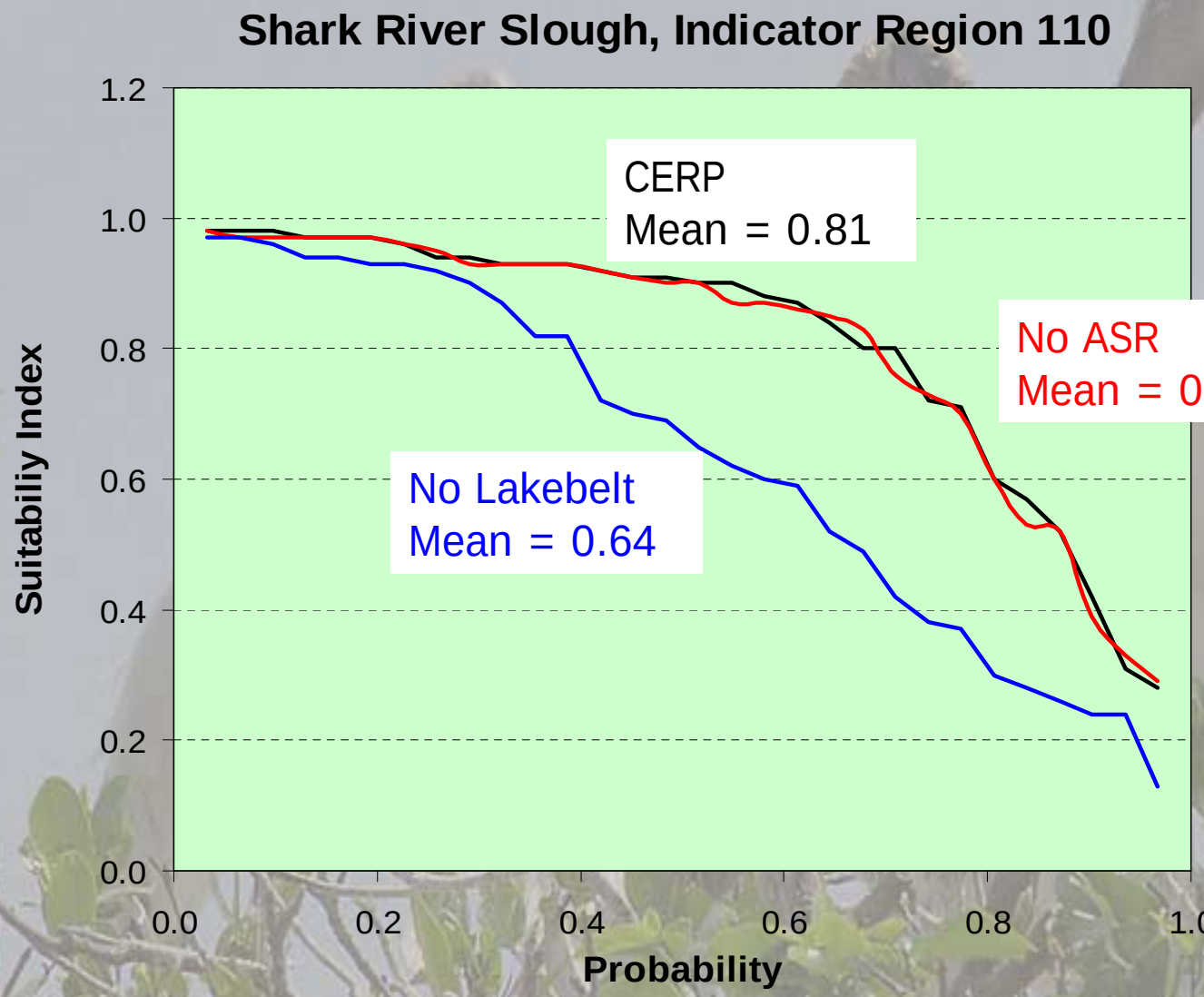
Lake Belt Storage Areas

- **North Lake Belt Storage Area (90,000 ac-ft)**
  - ➔ to capture stormwater runoff
  - ➔ to maintain canal stages and provide water deliveries to Biscayne Bay

- **Central Lake Belt Storage Area (190,000 ac-ft)**
  - ➔ to store excess water from Water Conservation Areas 2 and 3
  - ➔ to provide environmental water supply deliveries to Northeast Shark River Slough and Water Conservation Area 3B

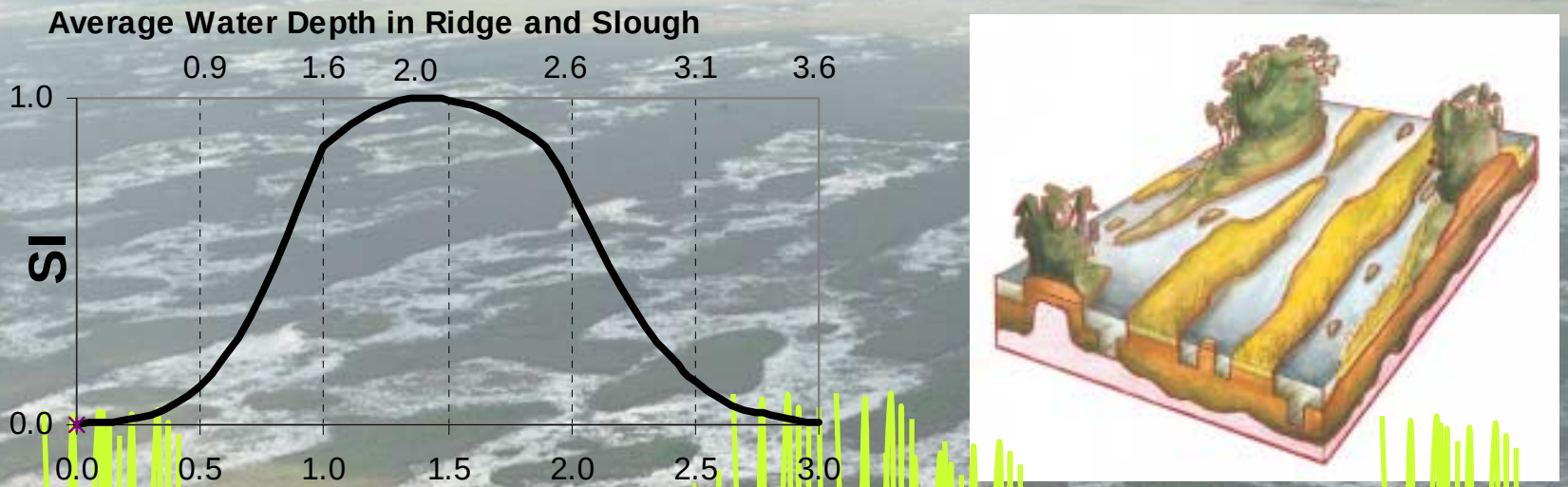


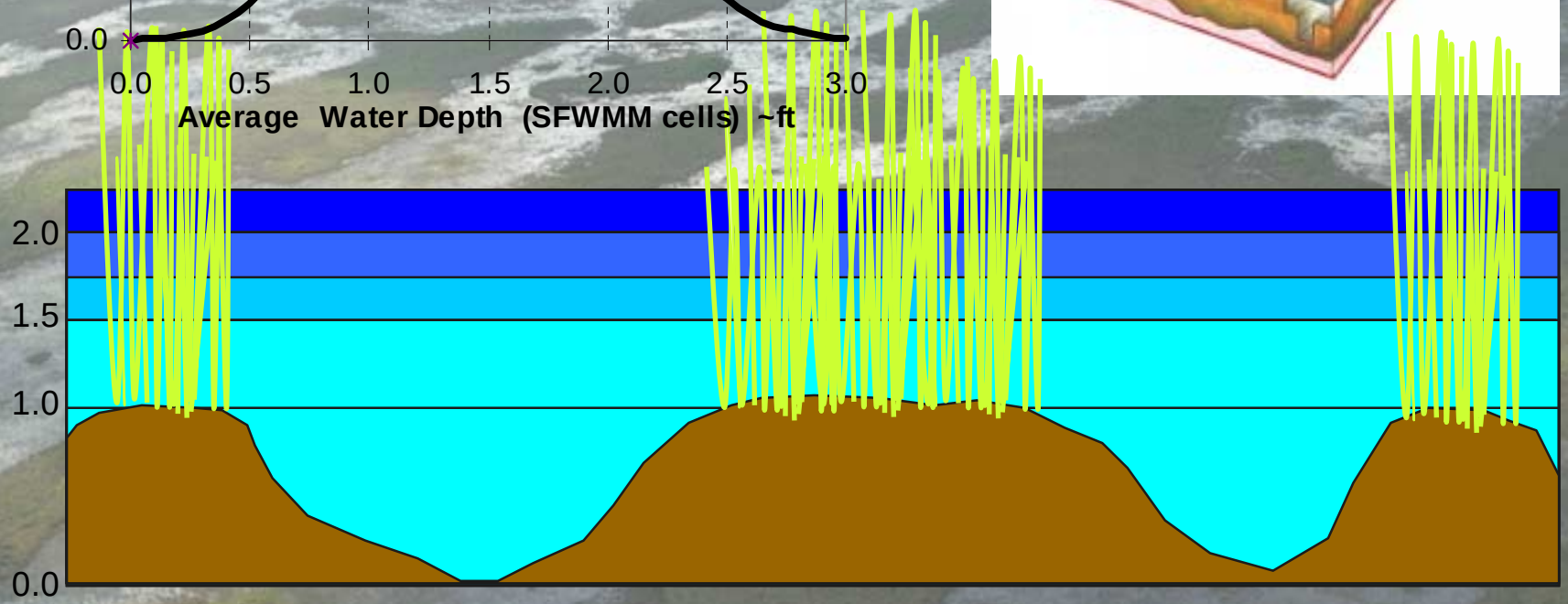
Scenario Comparisons



Sensitivity

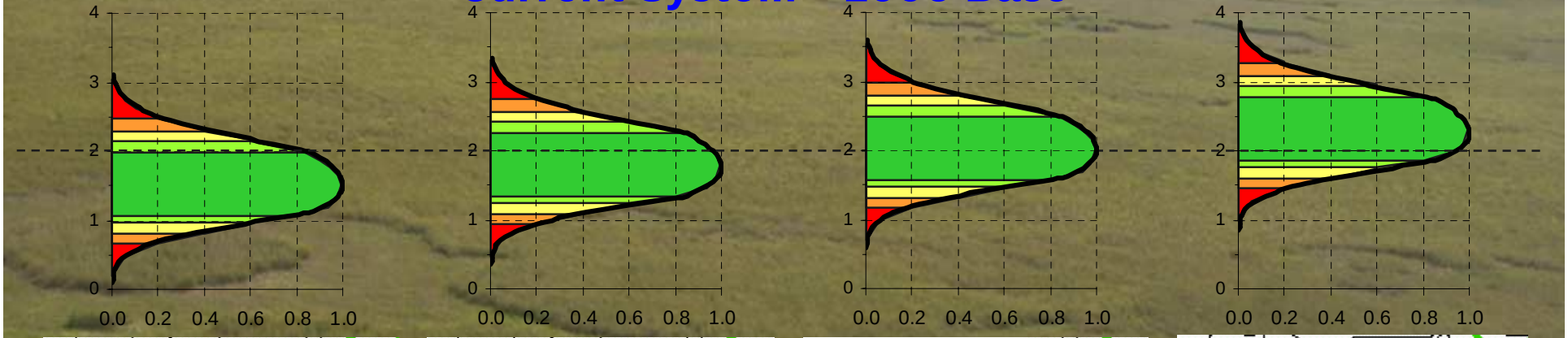
- Sensitivity analysis can be used to check robustness of functions.
- Sensitivity analysis undertaken for Ridge and Slough landscape, depth function.
- Optimal depth was adjusted +/- 3 inches and +/- 6 inches.
- Results shown for Current and Natural Systems.

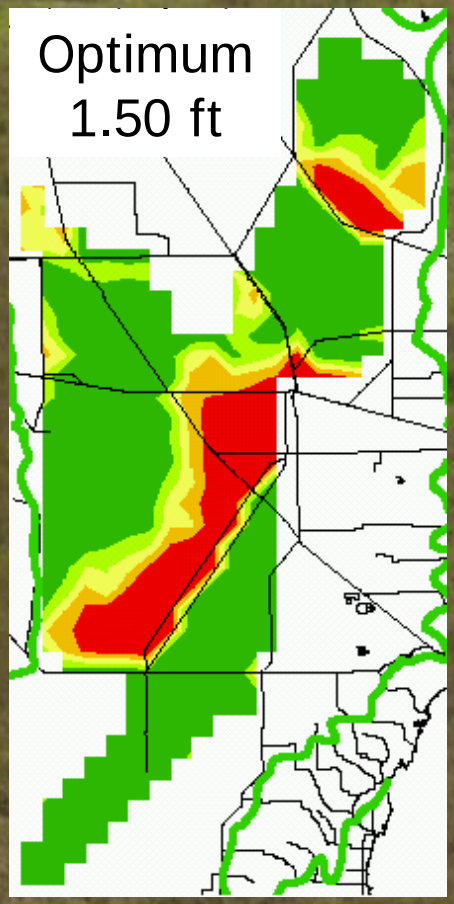


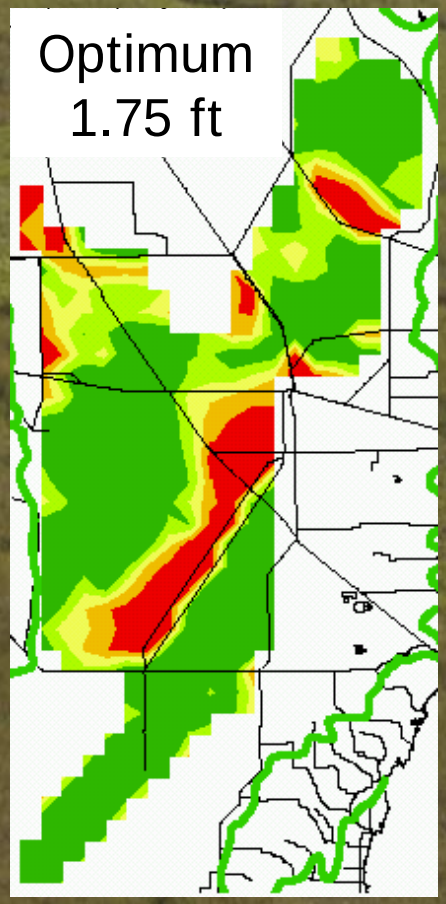


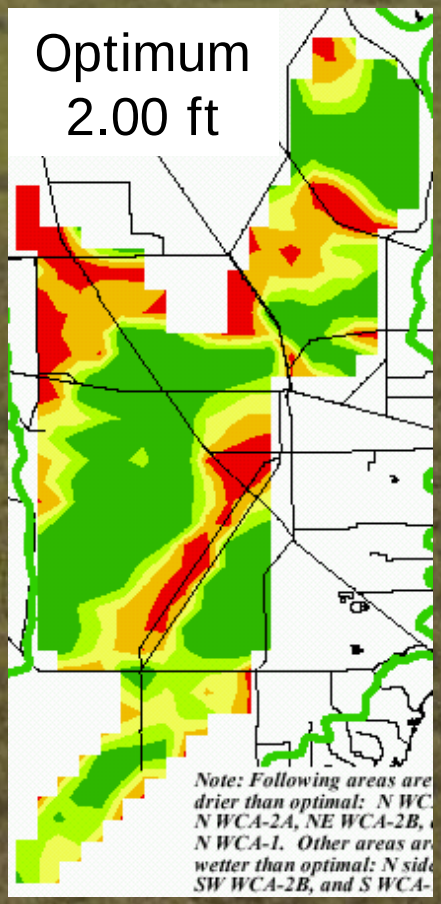
Ridge and Slough - Sensitivity to Depth

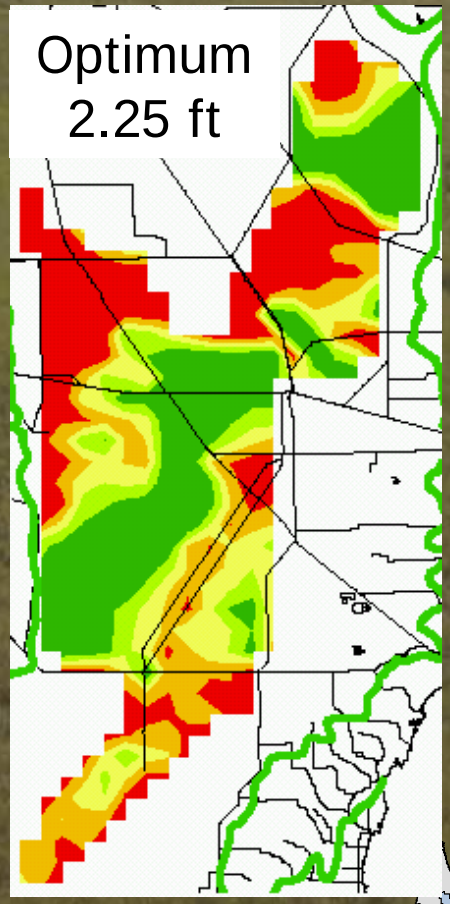
Current System - 1995 Base



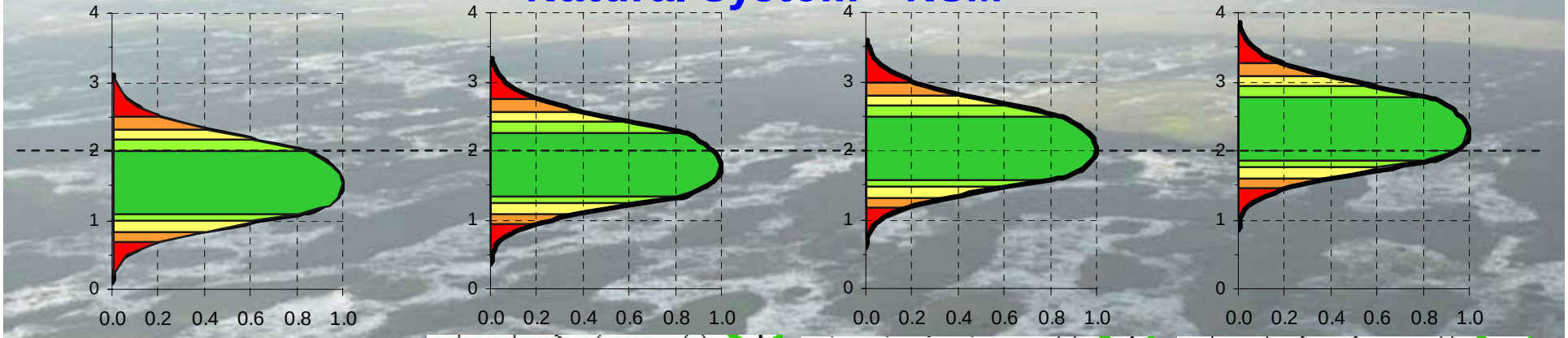


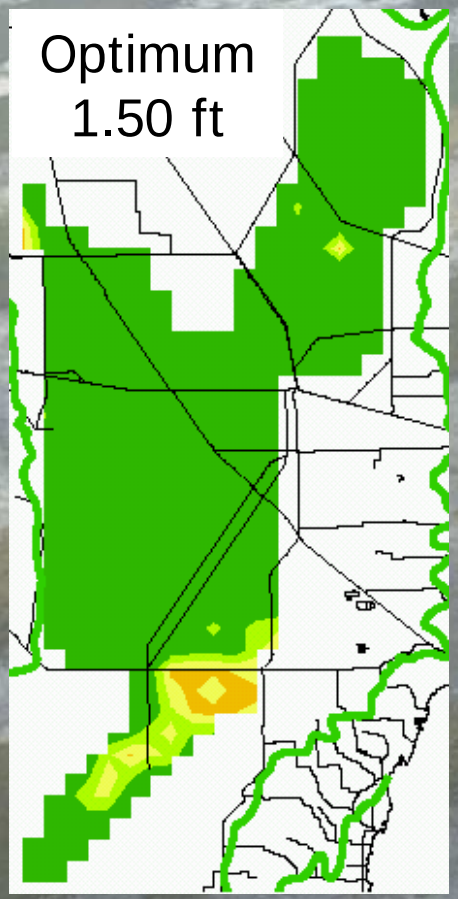


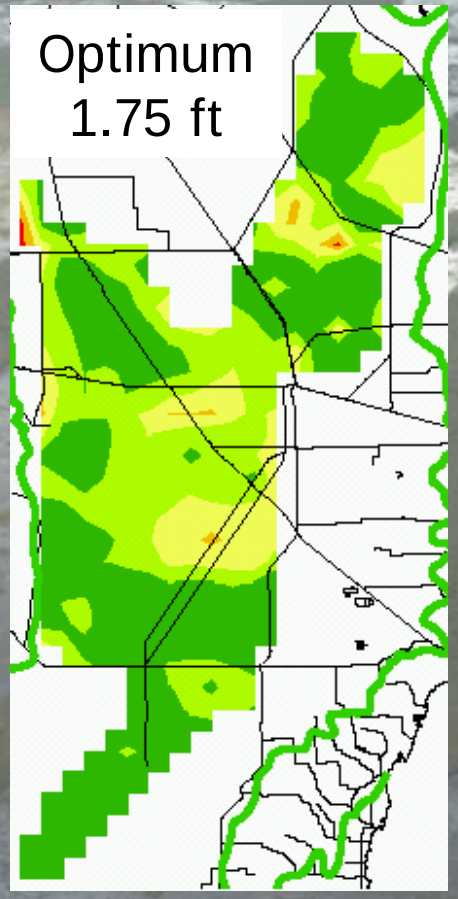


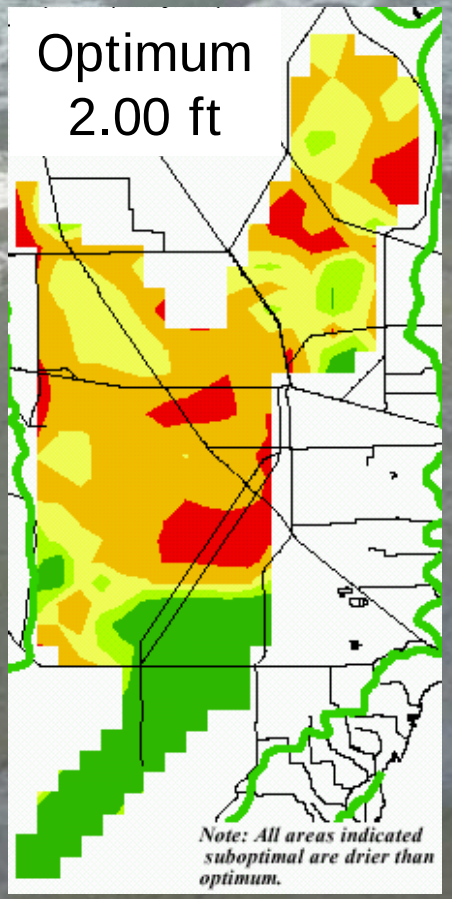


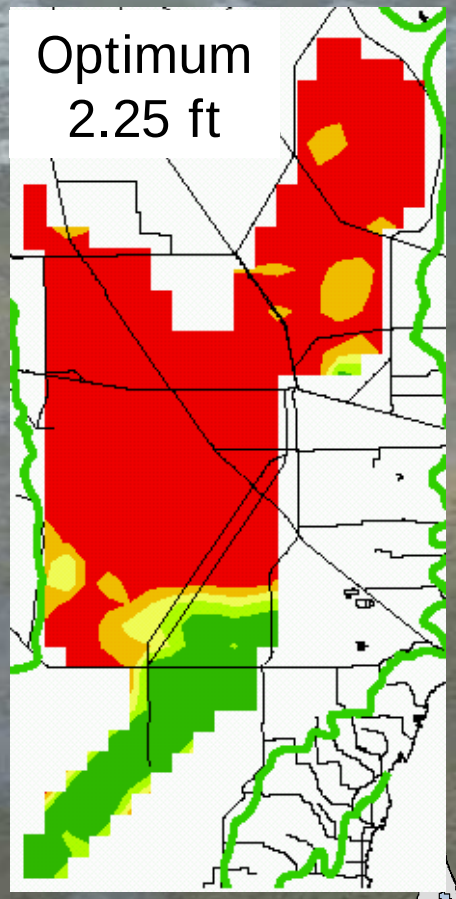
Natural System - NSM











HYDROLOGIC SYSTEMS MODELING

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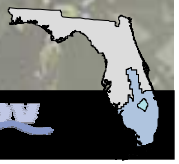
Summary

- Habitat SI's are simple, yet robust and useful indicators of ecological response to hydrologic stressors.
- Provide system-wide indication of ecological habitat response to alternative water management strategies.
- Can be used in regional analysis and possibly to provide indication of when and where more detailed ecological modeling is needed.

Summary continued ...

- Can be generated fairly quickly and in future could be automated directly from hydrologic model output.
- Functionality should be enhanced in future by using water quality stressors in addition to hydrologic stressors.
- Process has enhanced inter-disciplinary and inter-agency communication and increased understanding of the Everglades.




Thank You !